



July 2019

FEDERAL VEHICLE FLEETS

Agencies Have
Continued to
Incorporate
Alternative Fuel
Vehicles into Fleets,
but Challenges
Remain

Accessible Version

GAO Highlights

Highlights of [GAO-19-397](#), a report to congressional requesters

Why GAO Did This Study

Since 1988, a series of laws have been enacted and executive orders issued related to federal goals of reducing federal fleets' petroleum use and greenhouse gas emissions. For fiscal year 2017, federal agencies were required to: (1) to acquire certain types of vehicles, (2) to use more alternative fuel, and (3) to meet targets for reducing petroleum and per-mile greenhouse gas emissions. Federal agencies were also under a directive to increase acquisitions of zero emission (electric) vehicles.

GAO was asked to review federal agencies' efforts related to these fiscal year 2017 requirements. This report addresses: (1) how agencies reported meeting fleet energy requirements and how agencies efforts changed their fleets and (2) challenges agencies face related to further meeting fleet energy goals.

To conduct this review, GAO surveyed 29 federal agencies subject to fleet energy requirements and selected 5 agencies—of a variety of sizes and missions—for case studies. The case studies results are not generalizable to all agencies. GAO also: (1) reported on DOE's and GSA's data on federal fleets for fiscal years 2008 through 2017, including GSA's acquisition and cost data for fiscal year 2017, the most current data available; (2) reviewed DOE's and EPA's information on agencies' performance related to fiscal year 2017 requirements; and (3) interviewed federal officials. The directives to reduce per-mile greenhouse gas emissions and increase acquisitions of electric vehicles were revoked by an Executive Order issued in May 2018.

View [GAO-19-397](#). For more information, contact Andrew Von Ah at (202) 512-2834 or vonaha@gao.gov.

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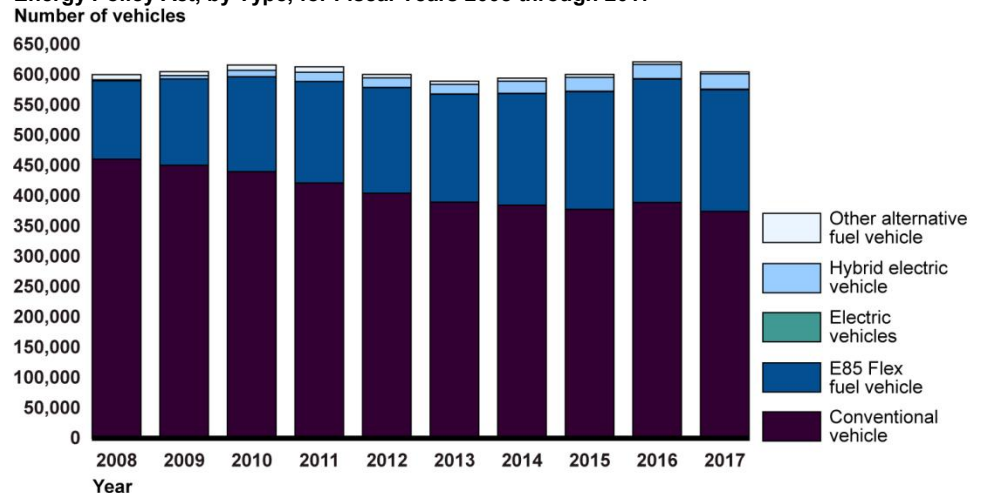
FEDERAL VEHICLE FLEETS

Agencies Have Continued to Incorporate Alternative Fuel Vehicles into Fleets, but Challenges Remain

What GAO Found

In responding to fleet management requirements over the past 10 years, agencies have incorporated an increasing number of alternative fuel vehicles into their fleets. These have been predominantly flex-fuel vehicles, as hybrid and battery electric vehicles continue to make up a small percentage of agencies' fleets (see figure). The Department of Energy (DOE) is responsible for overseeing agencies' compliance by analyzing fleet data. Most agencies reported meeting the fiscal year 2017 requirements to reduce petroleum use and per-mile greenhouse gas emissions. DOE and other agency officials attributed agencies' success in meeting these requirements to (1) acquiring low greenhouse-gas-emitting and alternative fuel vehicles, and (2) improving general fleet management such as by reducing miles traveled.

Total Numbers of All Domestic Alternative Fuel Vehicles for Federal Agencies Subject to the Energy Policy Act, by Type, for Fiscal Years 2008 through 2017



Source: GAO analysis of Federal Automotive Statistical Tool data. | GAO-19-397

Data table for Total Numbers of All Domestic Alternative Fuel Vehicles for Federal Agencies Subject to the Energy Policy Act, by Type, for Fiscal Years 2008 through 2017

Fuel Type	Conventional vehicle	E85 Flex fuel vehicle	electric vehicle (battery and plug-in hybrid)	Hybrid electric vehicle	Other alternative fuel vehicle
2008	460,618	129,251	83	1,766	8,448
2009	450,458	142,501	56	5,574	6,679
2010	439,867	156,689	71	10,621	8,732
2011	421,247	167,450	65	15,412	8,865
2012	404,318	174,469	240	15,883	5,495
2013	389,629	177,991	625	15,834	5,139
2014	384,676	184,042	678	19,887	5,096
2015	377,703	194,210	897	22,863	4,813
2016	389,254	203,497	791	23,519	4,270
2017	374,284	200,950	1,055	25,059	3,150

According to agency officials, three challenges have continued to hinder agencies' efforts to further the goals of reducing federal fleets' petroleum use and greenhouse gas emissions. First, while hybrid and electric vehicles can offer reductions in petroleum use and greenhouse gas emissions, the costs of these vehicles and their charging infrastructure make it challenging for agencies to acquire them on a large scale. According to GSA data, agencies purchased 373 electric vehicles (sedans and minivans) in fiscal year 2017—along with about 4,500 hybrid electric sedans—out of a total of over 16,000 sedans and minivans acquired. In total, agencies spent about \$10.5 million more to purchase hybrid or electric vehicles than they would have to purchase comparably sized conventionally fueled vehicles. However, agencies did not consistently track the life-cycle costs of these vehicles. Second, agencies also stated that a lack of fuel and infrastructure availability limits agencies' use of alternative fuel. Third, agency officials stated that a continuing need for larger vehicles limits the number of low greenhouse-gas-emitting vehicles agencies can acquire.

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Abbreviations

AFLEET	Alternative Fuel Life-Cycle Environmental and Economic Transportation
CEQ	Council on Environmental Quality
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
E85	gasoline and ethanol fuel blends (51–83 percent ethanol)
EPA	Environmental Protection Agency
FAST	Federal Automotive Statistical Tool
FleetDASH	Fleet Sustainability Dashboard
GSA	General Services Administration
OMB	Office of Management and Budget
RFS	Renewable Fuel Standard
VA	Department of Veterans Affairs

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July 26, 2019

The Honorable Ron Johnson
Chairman
The Honorable Gary C. Peters
Ranking Member
Committee on Homeland Security and Governmental Affairs
United States Senate

The Honorable James Lankford
Chairman
Subcommittee on Regulatory Affairs and Federal Management
Committee on Homeland Security and Governmental Affairs
United States Senate

The federal government, like the rest of the nation, has relied largely on petroleum-powered vehicles—i.e., gasoline or diesel fuel—in its fleets. In fiscal year 2017, these fleets included about 604,000 domestic vehicles that traveled over 4.5 billion miles to help meet a variety of government missions. Since 1988, a series of laws have been enacted and executive orders issued aimed at reducing federal fleets' reliance on petroleum.¹ Among other things, for fiscal year 2017, federal agencies were required to (1) acquire certain types of vehicles, such as vehicles that run on fuels other than petroleum or use gasoline efficiently; (2) increase use of alternative fuel; and (3) meet targets for reducing petroleum and per-mile greenhouse gas emissions. In light of these requirements, agencies have identified broad goals to reduce reliance on petroleum fuel and reduce greenhouse gas emissions.² As technological advancements have enabled manufacturers to develop a variety of vehicles that run on alternative fuels, agencies have had to balance costs, availability of

¹The Alternative Motor Fuels Act of 1988 required the acquisition of alcohol and natural gas vehicles. Pub. L. No. 100-494, § 4 (1988).

²These broad energy goals are identified in agency guidance for implementation of statutory requirements and directives.

alternative fuel vehicles that meet agencies' needs, and other issues with their efforts to meet these requirements.³

You asked us to review federal agencies' efforts and any challenges they face related to meeting the federal energy requirements and goals for vehicle fleets. This report addresses:

- how agencies meet fleet energy requirements and how agencies' efforts changed their fleet composition, and
- challenges federal agencies face related to furthering fleet energy goals.

The report also includes information on the extent to which agencies consider lifecycle costs when selecting vehicles.

To determine the extent to which federal agencies reported meeting fleet energy requirements and the composition of federal agencies' fleets, we analyzed data from the Federal Automotive Statistical Tool's (FAST) database on the composition and fuel use of federal agencies' fleets from fiscal years 2008 through 2017, the most current data available at the time of our review. Federal regulations direct agencies to submit information annually on all of their non-tactical vehicles (those not used for military purposes) to this database, which the Department of Energy (DOE) and General Services Administration (GSA) established in 2000.⁴ To assess the reliability of these data, we interviewed and collected written responses from DOE officials on how the data are collected, maintained, analyzed, and presented. This effort included how DOE flags suspicious data, reviews the data, and validates the final entries. Based on the information collected, we found the data sufficiently reliable for reporting on the composition and fuel use of federal agencies' fleets.

We reviewed federal statutes, regulations, and executive orders, and examined DOE and GSA guidance on the various applicable statutory requirements and executive orders. We reported on DOE or the Environmental Protection Agency's (EPA) assessment of agencies' performance relative to select statutory requirements and directives in

³For this review we focused on four types of alternative fuel vehicles: flex-fuel vehicles, hybrid-electric vehicles, plug-in hybrid electric vehicles, and battery electric vehicles. As of fiscal year 2017, these types of alternative fuel vehicles were the most numerous in federal fleets or were specifically mentioned in requirements.

⁴41 C.F.R. § 102-34.335.

executive orders (which we refer to as federal fleet energy requirements) that were in effect for fiscal year 2017. This effort included two directives that were issued in a 2015 Executive Order—to acquire zero emission vehicles and to reduce per mile greenhouse gas emissions. Subsequently, in May 2018, a new Executive Order issued by the current administration revoked the 2015 Executive Order, so that these two directives were no longer in effect for fiscal year 2018. Guidance for the new Executive Order was issued in April 2019.

We also identified five agencies for case study—Department of the Interior (Interior); Department of Veterans Affairs (VA); Department of Transportation (DOT); the Army; and the Environmental Protection Agency (EPA). We selected these agencies to include a variety of fleet sizes, vehicle compositions, and agency missions. We reviewed documents reporting on the extent to which these agencies met federal fleet energy requirements and interviewed agency officials, including fleet managers, to understand how they met these requirements. We spoke with these officials both before and after the 2015 Executive Order was revoked. The results from the case studies cannot be generalized to make inferences about all agencies.

To determine any challenges agencies face related to further meeting fleet energy goals, we reviewed information on costs, petroleum consumption, and greenhouse gas emissions of alternative fuel vehicles and petroleum-fueled vehicles offered for lease by GSA using DOE's Vehicle Cost Calculator and Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) tool and GSA's annual vehicle guides.⁵ We did not conduct a full life-cycle accounting of the relative environmental costs and benefits of alternative fuel vehicles compared to petroleum-fueled vehicles in federal fleets because we did not find reliable data to conduct a study of that detail. However, we reviewed available studies and government reports related to life-cycle accounting of the costs of alternative fuel vehicles compared to petroleum fueled vehicles in general. We also reviewed lease and purchase cost data provided by GSA for fiscal year 2017 for all federal agencies. We requested information from our case study agencies on actual costs of using alternative fuel vehicles, but agencies were unable to provide that information because they had not consistently tracked these data. In April

⁵DOE developed the AFLEET tool to enable users to estimate a vehicle's petroleum use, greenhouse gas emissions, air pollutant emissions, and cost of ownership based on the vehicle type, fuel-type, and various assumptions such as miles driven.

2018, we also surveyed 29 federal agencies subject to the requirements that support the fleet energy goals on challenges they have faced in meeting them.⁶ (See app. I for survey results).

At the time of the survey, the federal fleet energy requirements and directives for fiscal year 2017 were still in effect, as the 2015 Executive Order had not yet been revoked. We received a 100 percent response rate to our survey. We also reviewed documentation from these agencies, including their Strategic Sustainability Performance Plans and fleet management plans. The strategic sustainability plan is to prioritize agency actions to support the reduction of greenhouse gas emission and other agency wide targets. The fleet management plan is to specifically address how an agency's fleet will meet its greenhouse gas reduction targets and other relevant fleet requirements. In addition, we interviewed fleet managers and other agency officials from the case study agencies as well as GSA and DOE on the challenges agencies face related to fleet energy requirements and goals. For more information about our scope and methodology, see appendix II.

We conducted this performance audit from November 2017 to July 2019 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Fleet Energy Requirements and Directives

Federal agencies' fleets consist of many types of vehicles that support a variety of purposes. For example, federal vehicles may be used to carry staff and gear to remote, off-road locations to perform maintenance or other tasks; to transport and provide healthcare to veterans; or to support daily operations on military installations. Congress and several

⁶Overall, 31 federal agencies were subject to federal energy requirements in 2017. We excluded Court Services and Offender Supervision Agency because its fleet management is decentralized and the Defense Agencies within the Department of Defense (DOD) because it was small relative to other DOD agencies.

administrations have required federal agencies to take various steps to reduce federal fleets' petroleum use and greenhouse gas emissions. During fiscal year 2017, agencies were:

- to meet requirements to acquire alternative fuel vehicles and low greenhouse-gas-emitting vehicles;
- to increase use of alternative fuel; and
- to decrease use of petroleum and per-mile greenhouse gas emissions (see table 1).⁷

According to DOE guidance for the 2015 Executive Order, acquiring such vehicles and increasing the use of alternative fuels can facilitate the goals of reducing both petroleum use and greenhouse gas emissions.

Table 1: Selected Statutory Energy Requirements and Directives for Federal Fleets in Place for Fiscal Year 2017

	Energy requirement	Description
Vehicle acquisitions	Acquire alternative fuel vehicles	Acquire alternative fuel vehicles for 75% of new light-duty vehicle ^a acquisitions in metropolitan statistical areas by fleets of 20 or more (Energy Policy Act of 1992 ^b)
	Acquire low greenhouse-gas-emitting vehicles	Prohibits agencies from acquiring any light-duty vehicle or medium-duty ^c passenger vehicle that is not a low greenhouse-gas-emitting vehicle, unless an agency self-certifies that no low greenhouse gas vehicle is available to meet its needs or is reducing greenhouse gas emissions through an alternative measure. (Energy Independence and Security Act of 2007 ^d)
	Acquire zero emission (electric) vehicles	Acquire zero emission vehicles, such as battery electric vehicles, or plug-in hybrid vehicles for 20 percent of all new agency passenger vehicle acquisitions by fiscal year 2020, and for 50 percent by fiscal year 2025. ^e (Executive Order 13693 – revoked May 2018)
Alternative fuel use	Use alternative fuel in dual-fueled vehicles	Use only alternative fuels in dual-fueled alternative fuel vehicles unless granted a waiver by Department of Energy. A waiver can be granted if there is not a fueling station within 5 miles or 15 minutes of the vehicle's primary location or where the alternative fuel is unreasonably more expensive. (Energy Policy Act of 2005 ^f)
	Increase alternative fuel consumption	Increase overall annual alternative fuel consumption by 10 percent by October 1, 2015, and for each year thereafter, relative to the 2005 baseline. (Energy Independence and Security Act of 2007 ^g)

⁷According to EPA, the greenhouse gas emissions level for any given model year will be determined by estimating the level needed to designate approximately 25 percent of cars and 25 percent of light-duty trucks and medium-duty passenger vehicles as compliant with the Energy Independence Security Act of 2007. These vehicles can consume alternative fuels or petroleum and are considered low greenhouse-gas-emitting vehicles.

	Energy requirement	Description
Reduction targets	Reduce fleet petroleum consumption	Reduce annual petroleum consumption 20 percent by October 1, 2015, and for each year thereafter, relative to the 2005 baseline. (Energy Independence and Security Act of 2007 ^b)
	Reduce per-mile greenhouse gas emissions	Reduce fleet-wide per-mile greenhouse gas emissions by 4 percent by fiscal year 2017, by 15 percent by fiscal year 2021, and by 30 percent by fiscal year 2025, all relative to a fiscal year 2014 baseline ⁱ (Executive Order 13693 – revoked May 2018)

Source: GAO summary of federal requirements. | GAO-19-397

^aThe term light-duty motor vehicle means a vehicle of up to and including 8,500 pounds gross vehicle weight and can include cars, smaller pickup trucks, minivans, vans and sport-utility vehicles. Agencies may define any of these as passenger vehicles if used to carry passengers.

^bPub. L. No. 102-486, §303, 106 Stat. 2871 (1992).

^cMedium-duty passenger vehicles are of gross weight between 8,500 and 10,000 pounds, such as a pickup truck, which agencies can classify as a passenger vehicle if used to carry passengers.

^dPub. L. No. 110-140, § 141 (2007).

^e80 Fed. Reg. 15871 (Mar. 25, 2015). This Executive Order was subsequently revoked. 83 Fed. Reg. 23771 (May 22, 2018). Zero emission vehicles include fuel-cell vehicles. However, in 2018 and 2019 GSA did not offer any fuel-cell passenger vehicles.

^fPub. L. 109-58, § 701 (2005).

^gPub. L. No. 110-140 § 142 (2007).

^hPub. L. No. 110-140 § 142 (2007).

ⁱ80 Fed. Reg. 15871 (Mar. 25, 2015). This Executive Order was subsequently revoked. 83 Fed. Reg. 23771 (May 22, 2018).

For fiscal year 2017, in addition to meeting the above requirements, federal agencies were to meet other requirements related to overall fleet management. Federal regulations require agencies to complete a fleet management plan annually and conduct an assessment of their fleet at least every 5 years.⁸ In addition, an Executive Order issued by the prior administration in 2015 directed agencies to determine and plan for their optimum fleet inventory with emphasis placed on eliminating unnecessary or non-essential vehicles.⁹

Certain federal fleet energy directives in place in fiscal year 2017 were revoked by an Executive Order issued in May 2018. Specifically, directives related to acquiring zero emission (electric) vehicles and reducing per-mile greenhouse gas emissions, as well as the additional

⁸Federal agencies are to conduct a Vehicle Allocation Methodology assessment that reviews their vehicle fleet and determines the appropriate size, type, and number of vehicles to optimize the fleet. 41 C.F.R. §102-34.50(b). GSA requires federal agencies to conduct the assessment every 5 years.

⁹Executive Order 13693 directed agencies to conduct this review of their fleet as part of its Strategic Sustainability Performance Plan. 80 Fed. Reg. 15871 (Mar. 25, 2015).

fleet management expectations, were revoked.¹⁰ The Trump administration issued a new Executive Order requiring that the Secretary of Energy, in collaboration with other federal agencies, review existing federal vehicle fleet requirements and report to the Council on Environmental Quality (CEQ) and the Office of Management and Budget (OMB) regarding opportunities to optimize federal fleet performance, reduce associated costs, and streamline reporting and compliance requirements. According to DOE officials, DOE submitted a report to CEQ and OMB as required.

In April 2019, CEQ and OMB issued implementing instructions for the Executive Order.¹¹ The implementing instructions emphasized that agencies should focus on the statutory requirements while increasing efficiency, optimizing performance, and reducing waste and costs. The guidance particularly emphasized agencies' focus on reducing petroleum use and increasing alternative fuel consumption. The guidance did not mention the extent to which agencies should continue to acquire any specific type of alternative fuel vehicle.

Annually, federal agencies are responsible for reporting vehicle inventory (including acquisitions and disposals), fuel consumption, mileage, and cost to the FAST database. Additionally, federal agencies are required to annually report on their fleets' inventories, operating costs, and other fleet data.¹² Costs submitted to the FAST database include acquisition costs, maintenance, fuel costs, indirect costs, commercial lease, GSA lease, and disposal proceeds. Prior to fiscal year 2017, agencies submitted this data at an aggregate, rather than the vehicular level, so that costs or other performance could not be analyzed at the vehicular level. For fiscal year 2017, as required by GSA and DOE, agencies began submitting vehicular level data to the FAST database, providing more detail about agency's vehicles.¹³ The FAST database specifically tracks data to assess agencies' performance relative to fleet energy requirements in federal statute and executive orders.

¹⁰80 Fed. Reg. 15871 (Mar. 25, 2015); 83 Fed. Reg. 23771 (May 22, 2018).

¹¹The Executive Order directed CEQ to review and where needed, revise existing guidance.

¹²41 C.F.R. § 102-34.335.

¹³According to DOE officials, not all agencies were able to provide vehicular level data for fiscal year 2017. Furthermore, GSA indicated they expected that fiscal year 2018 vehicular level data would be usable for analysis by government agencies.

Alternative Fuel Vehicles

A range of vehicles qualify as alternative fuel vehicles (see fig. 1). This range includes vehicles that run entirely on alternative fuel, such as electricity, and dual-fueled vehicles that can run on an alternative fuel as well as on gasoline, such as flex-fuel vehicles, which can run on gasoline or ethanol fuel blends (E85).¹⁴ In 2008, the definition of alternative fuel vehicles was amended to include hybrid electric vehicles, which run on gasoline with help from an electric battery, and, in certain circumstances, other vehicles that would achieve a significant reduction in petroleum consumption, such as highly fuel efficient gasoline vehicles that are also low greenhouse gas-emitting vehicles.¹⁵

¹⁴Flex-fuel vehicles can operate on an ethanol blend, E85, or exclusively on gasoline. E85 is a blend of up to 85 percent ethanol and 15 percent gasoline. Alternative fuel vehicles also include those that operate on natural gas, bio-diesel, and propane powered vehicles. Gasoline can also be a blend of up to 10-15 percent ethanol. In fiscal year 2019, GSA offered 14 different hybrid electric and plug-in hybrid electric passenger vehicles including a Ford Fusion hybrid electric vehicle and a Hyundai Sonata plug-in hybrid electric vehicle. GSA only offered one battery-electric vehicle, the Chevrolet Bolt.

¹⁵The National Defense Reauthorization Act for Fiscal Year 2008 modified the definition of alternative fuel vehicles to include qualified fuel cell vehicles. Pub. L.No. 110-181, § 2862 (2008). According to DOE, when locating these low greenhouse-gas-emitting vehicles they must be in areas where alternative fuel is not reasonably available or is unreasonably expensive.

Figure 1: Select Types of Light-duty Alternative Fuel Vehicles Available to Federal Agencies through the General Services Administration's Fiscal Year 2019 Alternative Fuel Vehicle Guide

Vehicle type	Fuel source	Available sizes offered by General Services Administration's (GSA) Product Guide ^a	How they work
Flex fuel vehicle	 Gasoline  Ethanol	 Midsize sedan  Light duty SUV  Light duty trucks  Light duty passenger van	Powered by a traditional internal combustion engine.
Hybrid electric vehicle	 Gasoline	 Subcompact sedan  Midsize sedan  Light duty SUV  Light duty trucks  Light duty passenger van	Powered by a traditional internal combustion engine and by an electric motor that uses energy stored in a battery. The battery can be charged by regenerative braking or other means. ^b
Plug-in hybrid electric vehicle	 Gasoline  Electricity	 Subcompact sedan  Midsize sedan  Light duty SUV  Light duty trucks  Light duty passenger van	Powered by a traditional internal combustion engine and by an electric motor that uses energy stored in a battery. The battery can be charged by plugging it into an electric power source as well as through regenerative braking and other means. ^c
Battery electric vehicle	 Electricity	 Subcompact sedan  Midsize sedan  Light duty SUV  Light duty trucks  Light duty passenger van	Powered by one or more electric motors that use energy stored in a battery. The battery can be charged by plugging it into an electric power source and through regenerative braking.

Sources: GSA and Department of Energy. | GAO-19-397

Data table for Figure 1: Select Types of Light-duty Alternative Fuel Vehicles Available to Federal Agencies through the General Services Administration's Fiscal Year 2019 Alternative Fuel Vehicle Guide

	Flex fuel vehicle	Hybrid vehicle	Plug-in hybrid electric vehicle	Battery electric vehicle
Fuel source	- Gasoline - Ethanol	Gasoline	- Gasoline - Electricity	Electricity
Available sizes offered by General Services Administration's (GSA) Product Guide ^a	- Subcompact sedan - Midsize sedan - Light duty SUV - Light duty trucks - Light duty passenger van	- Subcompact sedan - Midsize sedan - Light duty SUV	- Subcompact sedan - Midsize sedan - Light duty SUV - Light duty passenger van	Subcompact sedan
How they work	Powered by a traditional internal combustion engine.	Powered by a traditional internal combustion engine and by an electric motor that uses energy stored in a battery. The battery can be charged by regenerative braking or other means. ^b	Powered by a traditional internal combustion engine and by an electric motor that uses energy stored in a battery. The battery can be charged by plugging it into an electric power source as well as through regenerative braking and other means. ^c	Powered by one or more electric motors that use energy stored in a battery. The battery can be charged by plugging it into an electric power source and through regenerative braking.

Note: General Services Administration (GSA) is the mandatory source for the purchase of federal agency non-tactical vehicles and also offers a vehicle leasing program to federal customers. In this role, GSA develops an Alternative Fuel Vehicle guide annually that outlines the available alternative fuel vehicle configurations to the federal government. In 2019, GSA vehicle offerings include a Chevrolet Bolt (battery electric), a Ford Fusion (plug-in hybrid electric), and a Hyundai Ioniq (hybrid electric), among others. In addition to flex fuel vehicles, hybrid electric vehicles, plug-in hybrid electric vehicles, and battery-electric vehicles, for fiscal year 2019, GSA also offered other types of alternative fuel vehicles, including bio-diesel capable vehicles, compressed natural gas vehicles, propane vehicles, and liquefied natural gas vehicles. A full listing of the available alternative fuel vehicles can be found in the Alternative Fuel Vehicle guide at <https://www.gsa.gov/buying-selling/products-services/transportation-logistics-services/vehicle-leasing/alternative-fuel-vehicles-technology/alternative-fuel-vehicle-afv-guides-and-helpful-links>.

^aAs part of our analysis of GSA's offered vehicles above, we refer to vehicles that are classified as compact and midsize sedans as "midsized" since they both have 4 doors and can fit 5 passengers. See 40 C.F.R. § 600.315.

^bRegenerative braking allows electric vehicles to capture energy normally lost during braking by using the electric motor as a generator and storing that captured energy in the battery.

^cBatteries in plug-in hybrid electric vehicles are larger than those in a hybrid electric vehicle and allow it to travel on electricity alone.

Alternative fuel vehicles, including electric vehicles, can offer environmental benefits compared to similarly-sized conventional petroleum-fueled vehicles but also carry their own environmental costs. For example, flex-fuel vehicles, if fueled by E85, reduce petroleum use because E85 consists of up to about 85 percent ethanol¹⁶, and according to DOE, using ethanol as a vehicle fuel reduces greenhouse gas emissions, along with emission of other harmful toxics.¹⁷ However, using ethanol increases other harmful emissions deemed carcinogenic and may also contribute to ozone formation.¹⁸ Furthermore, as we reported in May 2019, the production of biofuels, such as ethanol, just like the production of gasoline, results in greenhouse gas emissions throughout its life-cycle—including growing the corn feedstock, transporting it, converting it to ethanol, distributing the ethanol, and burning it in an engine. Other emissions are released indirectly through broad economic changes associated with increased biofuel use, including increased ethanol use, such as when changes in land use to grow corn cause the conversion of previously nonagricultural lands into agricultural lands. Nonetheless,

¹⁶According to DOE's Alternative Fuels Data Center, E85 (or flex fuel) is a term that refers to ethanol-gasoline blends containing 51% to 83% ethanol, depending on geography and season.

¹⁷Other harmful toxics from vehicle emissions include benzene, which is a known carcinogen.

¹⁸DOE oversees the Alternative Fuels Data Center's website where more information on ethanol emissions can be found. Accessed May 31, 2019. https://afdc.energy.gov/vehicles/flexible_fuel_emissions.html.

recent studies have found the life-cycle emissions of corn ethanol to be lower than those of gasoline¹⁹.

Similarly, battery-electric, plug-in hybrid electric, and hybrid-electric vehicles rely on batteries for all or some of their power, reducing or eliminating petroleum use and associated tailpipe greenhouse gas emissions, but charging, producing, and disposing of these batteries can result in environmental effects. With respect to charging, the production of electricity to power these vehicles results in emissions, the amount of which is dependent on the source of the electricity, a factor we discuss in greater detail later in this report. With respect to production, GAO previously reported that extracting lithium and other minerals from locations where it is abundant, such as in South America, can pose environmental challenges that would damage the ecosystems in these areas.²⁰ With respect to disposal, according to DOE's alternative-fuels data center, the disposal of batteries used in electric and hybrid-electric vehicles can result in hazardous materials entering the waste stream—but work is under way to develop battery recycling processes that minimize the life-cycle effects of such batteries. According to DOE, as electric-drive vehicles become increasingly common, the battery-recycling market may expand.²¹

In addition, the climate in which battery-electric and plug-in electric vehicles are used can affect the life of the battery. However, federal agencies do not collect the data that would allow analysis of these effects specific to the use of vehicles in federal agencies' fleets. Furthermore,

¹⁹GAO. *Renewable Fuel Standard: Information on Likely Program Effects on Gasoline Prices and Greenhouse Gas Emissions*, [GAO-19-47](#) (Washington, D.C.: May 3, 2019). This report focused on the 2005 Renewable Fuel Standard (RFS), which mandates that transportation fuels sold in the United States contain increasing amounts of biofuels—which to date have mostly been corn ethanol—to reduce greenhouse gas emissions, among other things. We reported that experts we interviewed generally agreed that the RFS has likely had a limited effect on such emissions. In 2016, we also reported that advanced biofuels can achieve greater emissions reductions than corn ethanol, but such biofuels have been uneconomical to produce at the volumes required by the RFS. GAO, *Renewable Fuel Standard: Program Unlikely to Meet Its Targets for Reducing Greenhouse Gas Emissions*, [GAO-17-94](#) (Washington, D.C.: Nov. 28, 2016).

²⁰See GAO, *Federal Energy and Fleet Management: Plug-in Vehicles Offer Potential Benefits, but High Costs and Limited Information Could Hinder Integration into the Federal Fleet*, [GAO-09-493](#) (Washington, D.C., June 9, 2009).

²¹DOE, Alternative Fuels Data Center, accessed May 29, 2019.
https://afdc.energy.gov/vehicles/electric_batteries.html

emissions related to fuel production or battery production or disposability are not incorporated into the requirements placed on federal agencies with respect to their fleets.²² As we discuss in more detail later, the various types of alternative fuel vehicles vary in the extent to which they can help agencies meet existing requirements to reduce petroleum use and the subsequently revoked requirement in place for fiscal year 2017 to reduce tailpipe greenhouse gas emissions.

Federal Responsibilities

According to DOE officials, DOE is responsible for overseeing energy goals and requirements and assists agencies in meeting these federal energy requirements. DOE tracks whether federal agencies are meeting the fleet energy requirements by analyzing the fleet inventory, fuel consumption, and fuel use data uploaded to the FAST database. DOE also oversees the Fleet Sustainability Dashboard (FleetDASH) database. FleetDASH tracks agencies' fuel consumption through data produced when employees use fuel cards.²³ This tool can track where vehicles are filling up and if there was an alternative fuel station nearby that could have been used.²⁴ FleetDASH can also provide agency fleet managers with reports on alternative fuel use and when drivers missed opportunities to fuel with alternative fuels. DOE also issues guidance and conducts research into vehicle technologies that can support energy requirements, including electric vehicles. In prior work, we recommended that DOE develop guidance for agencies that specifies the elements that agencies should include in their plans for acquiring a mix of vehicles to meet federal requirements and goals. In June 2010, DOE issued the *Comprehensive Federal Fleet Management Handbook*, implementing this recommendation. DOE's Fleet Management Handbook recommends to agencies how to develop greenhouse gas and petroleum reduction strategies and acquire vehicles in support of these strategies, among

²²According to GSA, these negative effects in the life-cycle are also seen in other vehicle fuel types, such as petroleum fueled vehicles from drilling for petroleum.

²³According to DOE staff, a fleet fuel card is used to track the fuel type, transactions, and use which is captured in FleetDASH. However, according to DOE, for a small percentage of fuel transactions, the data, particularly the type of fuel, has been found to be inaccurate due to gas stations' mis-identifying the type of fuel being pumped.

²⁴According to DOE, while FleetDASH is primarily used to identify ethanol use and consumption but can also be used to identify fueling stations for other types of alternative fuels, such as natural gas stations, electric-vehicle-charging stations, and other types of alternative fuel stations.

other issues. DOE also has developed online tools to help provide guidance to agencies and consumers on the fuel efficiency and environmental effects of vehicles.

GSA is responsible for providing vehicles for federal agencies to purchase or lease. GSA is a mandatory source for purchase of new vehicles for executive agencies and other eligible users.²⁵ Federal agencies can also use GSA to acquire leased vehicles. Under this arrangement, an agency informs GSA what kind of vehicle is necessary for its mission.²⁶ Every year, GSA publishes an annual guide on vehicles available for purchase or lease that includes the vehicles' fuel type, purchase and lease prices, size, and other specifications.

In setting the lease prices, GSA is required by law to recover all costs it incurs in providing vehicles and services to federal customers.²⁷ Agencies that lease vehicles from GSA generally pay a monthly rate and a mileage rate.²⁸ These charges are designed to cover fixed costs such as: (1) the vehicle's acquisition cost; (2) administrative costs (including staff and facilities); and (3) depreciation—as well as the variable costs of fueling (except electricity used²⁹) and vehicles' maintenance. In the case of alternative fuel vehicles, if the cost of the vehicle is greater than that of an equivalent conventional vehicle, agencies must cover these higher costs.³⁰ Pursuant to law, GSA distributes these higher costs for alternative fuel vehicles across the agency's entire leased fleet via a flat per-vehicle monthly surcharge in the year the vehicle was acquired. Surcharges are set at the agency headquarters' level. According to a GSA fact sheet, this approach allows GSA to offer a greater variety of alternative fuel vehicles

²⁵41 C.F.R. § 101-26.501-1.

²⁶According to GSA officials, an agency that lacks specific authority to purchase or hire passenger motor vehicles or has not been delegated leasing authority is required to participate in the GSA's centralized leasing program.

²⁷40 U.S.C. § 605(b).

²⁸Leased vehicles have an associated fleet fuel card to purchase fuel that is charged to GSA.

²⁹Effective June 2019, electricity usage is now covered in rates for certain charging stations that accept the GSA Fleet Services Card.

³⁰The higher cost of an alternative fuel vehicle is referred to as the "incremental" cost, and GSA is required to allocate the incremental cost over the entire fleet. 42 U.S.C. § 13212(c).

without affecting lease rates of non-alternative fuel vehicles and spread the additional cost across all agencies.³¹

At times, GSA has conducted special pilot programs that have waived higher costs of alternative fuel vehicles in order to test new technology. For example, in 2011 and 2014, GSA ran two pilot programs that added over 300 electric vehicles and charging stations to the fleet. According to GSA officials, these pilots were designed to help GSA Fleet understand more about the performance, costs, and maintenance needs of electric vehicles to help them prepare for the potential increase in electric vehicles in the fleets in order to better advise other agencies on these vehicles' use and operation. In these programs, GSA spent over \$5.9 million covering the additional costs for the electric vehicles and spent another \$1.2 million on purchasing electric-vehicle-charging stations.

Agencies Reported Meeting Most Fleet Energy Requirements by Adding More Alternative Fuel Vehicles to their Fleets and Improving Fleet Management

The majority of agencies subject to federal-fleet energy requirements reported meeting most requirements for fiscal year 2017 by changing the mix of vehicles acquired and improving fleet management.³² Specifically, agencies credited acquiring low greenhouse-gas-emitting and alternative fuel vehicles for helping to reduce petroleum use and per-mile greenhouse gas emissions. Agencies also described improving their fleet management in other ways, such as removing unnecessary vehicles and reducing miles traveled in order to reduce petroleum use and greenhouse gas emissions. Agencies' fleets reflected increasing numbers of

³¹According to GSA, the variety of alternative fuel vehicles available is the result of what vehicle manufacturers and vendors are producing and offering to GSA.

³²Specifically, federal agencies subject to federal fleet requirements are to report data to the FAST database that pertains to the federal fleet requirements. In some cases, the agencies report on whether they have met requirements based on this data; in other cases, DOE has reported on whether agencies met the requirement, and in the case of the requirement to acquire low greenhouse-gas-emitting vehicles, EPA reports on whether agencies have met the requirement, also based on data reported by agencies in the FAST database.

alternative fuel vehicles over the past 10 years, predominantly flex-fuel vehicles.

Agency Officials Stated That Acquisitions and Better Fleet Management Helped Reduce Petroleum Use and Greenhouse Gas Emissions

DOE and other agency officials we spoke with from agencies that met the reduction targets for petroleum use and per-mile greenhouse gas emissions generally attributed their ability to meet these requirements to efforts in two areas:

1. acquiring low greenhouse-gas-emitting vehicles whenever they could (even if they did not meet the related requirement) as well as alternative fuel vehicles, and
2. improving fleet management in other ways, such as by eliminating unnecessary vehicles or driving fewer miles, in line with GSA's fleet management guidance.

In line with these efforts, a majority of agencies reported meeting most fleet energy requirements for fiscal year 2017 (see table 2).³³

Table 2: Total Number of Federal Agencies That Reported Meeting Selected Statutory Energy Requirements and Directives for Federal Fleets for Fiscal Year 2017

Requirement category	Requirement description	Number of the 29 agencies GAO reviewed that were reported as meeting the requirement
Vehicle acquisitions	Acquire alternative fuel vehicles for 75 percent of the total number of light-duty passenger vehicles in metropolitan statistical areas per fiscal year ^a	24

³³Neither agencies nor DOE reported directly on the extent to which agencies met the requirement to use alternative fuel in dual-fueled vehicles. According to DOE officials, they report on the total amount of alternative fuel consumed and estimate the alternative fuel consumed by dual-fueled vehicles that have access to fuel. Agencies may self-certify that no low greenhouse gas vehicle is available to meet its needs or that the agency is reducing its use of petroleum through an alternative measure. According to DOE, once an agency self-certifies for one of these exceptions, the acquisition of a non-low greenhouse-gas-emitting vehicle does not count against the requirement.

Requirement category	Requirement description	Number of the 29 agencies GAO reviewed that were reported as meeting the requirement
	Acquire low greenhouse-gas-emitting vehicles for all light-duty and medium-duty passenger vehicles	8 ^b
Alternative fuel use^c	Increase alternative fuel consumption 10 percent by October 1, 2015 and for each year thereafter, relative to the baseline established by Department of Energy for 2005	24
Reduction targets	Reduce petroleum consumption 20 percent by October 1, 2015 and for each year thereafter, relative to the baseline established by Department of Energy for 2005	21
	Reduce per-mile greenhouse gas emissions by 4 percent in fiscal year 2017, relative to a fiscal year 2014 baseline based on the volume of fuel consumed in 2014 (requirement was revoked in May 2018) ^d	21

Source: Department of Energy (DOE) and Environmental Protection Agency reports of the Federal Automotive Statistical Tool (FAST) data. | GAO-19-397

^aPub. L. No. 102-486, § 303.

^bAccording to GSA staff, the low number of low greenhouse gas vehicles being reported is most likely a result of how the vehicles are identified and reported, and the number reported is lower than the number acquired.

^cAgencies are also required to use alternative fuel in their dual-fuel use vehicles. Pub. L. No. 109-58, § 701. DOE reports on the total amount of alternative fuel consumed in fleet vehicles and estimated alternative fuel use by dual-fueled vehicles. DOE also processes waiver requests that agencies submit.

^dThis directive was included in the Executive Order, which has been revoked by Executive Order 13834. 80 Fed. Reg. 15871 (Mar. 25, 2015); 83 Fed. Reg. 23771 (May 22, 2018).

Acquiring Low Greenhouse Gas and Alternative Fuel Vehicles

Fleet managers at two of the case study agencies said that acquiring low greenhouse-gas-emitting vehicles was key to their ability to meet the fiscal year 2017 targets for reducing petroleum use or greenhouse gas emissions. For example, although VA reported not meeting the low greenhouse-gas-emitting acquisitions requirement for fiscal year 2017, VA officials said that they did acquire low greenhouse gas vehicles when they could, and that to the extent they acquired such vehicles, it was the primary reason they were able to reduce their per-mile greenhouse gas emissions by 24 percent from fiscal year 2014 to fiscal year 2017. This reported reduction far exceeded the requirement for a 4 percent reduction

in per-mile greenhouse gas emissions during this time frame. According to VA officials, VA's acquisition process requires them to consider low greenhouse-gas-emitting vehicles for each acquisition and to select one whenever one is available that will meet the purpose for the vehicle.

According to VA officials, the reason VA reported not meeting the low greenhouse-gas-emitting acquisitions requirement for fiscal year 2017 was that the agency did not consistently self-certify for exceptions to the requirement in cases where there was no low greenhouse-gas-emitting vehicle available that met their mission needs, an issue we also heard from GSA officials.³⁴ (As shown in table 2, above, this was the one fleet-energy requirement that was reported as being met by less than a majority of the 29 agencies, with 8 reporting meeting this requirement for fiscal year 2017).

Fleet managers at all of our case study agencies emphasized that they sought to acquire low greenhouse-gas-emitting vehicles whenever one was available that would serve their needs. GSA officials told us agencies are acquiring significant numbers of low greenhouse gas vehicles. By their count, of the sedans agencies acquired in fiscal year 2018, 92 percent were low greenhouse-gas-emitting vehicles; of the light-duty sport-utility vehicles and trucks agencies acquired, 45 percent were low greenhouse-gas-emitting vehicles. GSA officials stated that according to their analysis, it is likely that the low number of low greenhouse gas vehicles being reported is a result of how the vehicles are identified and reported, and that the number reported is lower than the number acquired. Vehicles considered to be low greenhouse-gas-emitting vehicles include selected makes and models of conventionally fueled vehicles that were identified by EPA as highly efficient, as well as different types of alternative fuel vehicles, such as selected makes and models of flex fuel vehicles, plug-in hybrid electric vehicles, and hybrid electric vehicles, and all battery electric vehicles.³⁵ Thus, the costs of vehicles

³⁴Agencies are prohibited from acquiring a vehicle that is not a low greenhouse-gas-emitting vehicle unless the agency certifies in writing that: (1) no low greenhouse-gas-emitting vehicle is available to meet the agency's functional needs, or (2) the agency implemented alternative measures to reduce petroleum use. Pub. L. No. 110-140, § 141.

³⁵Compliance levels are based on specific carbon dioxide emissions levels. The carbon dioxide emissions level threshold for any given model year will be determined by estimating the level needed to designate approximately 25 percent of cars and 25 percent of light-duty trucks and medium-duty passenger vehicles as compliant.

considered to be low greenhouse-gas-emitting vary widely. We discuss later in the report the costs of different types of alternative fuel vehicles.

Along with the acquisition of low greenhouse- gas-emitting vehicles generally, fleet managers at some case study agencies stated that their acquisition and use of alternative fuel vehicles also helped them to meet the fiscal year 2017 targets for reducing petroleum and per-mile greenhouse gas emissions. Fleet managers at two agencies we spoke with stated or reported that their acquisitions of hybrid vehicles and, to a lesser extent, small numbers of plug-in hybrid and battery electric vehicles also helped managers to meet petroleum and greenhouse gas emissions reduction targets.³⁶ According to Interior's fiscal year 2015 Strategic Sustainability Performance Plan, over 1,300 hybrids helped the agency reduce petroleum consumption, increase fuel efficiency, and reduce greenhouse gas emissions. Within Interior, officials at the National Park Service told us that they replaced older, inefficient gas vehicles with more fuel efficient hybrids. EPA officials stated that acquiring hybrid vehicles and plug-in hybrid electric vehicles helped them exceed their per-mile greenhouse gas emission reduction target for fiscal year 2017 by just over 9 percent. Furthermore, of the 29 agencies we surveyed, 20 identified that a key benefit to acquiring battery-electric or plug-in hybrid electric vehicles was environmental, particularly in reducing greenhouse gas emissions.

In addition, some fleet managers emphasized the role that flex-fuel vehicles fueled with E85 had played in their efforts to meet these targets. Some agencies told us that they acquired flex-fuel vehicles to meet alternative fuel vehicle acquisition requirements, and that using E85 in these vehicles contributed to reducing petroleum use and per-mile greenhouse gas emissions.³⁷ For example, DOT's fleet manager stated that DOT's acquisition of flex-fuel vehicles and focus on using E85 to fuel those vehicles when available helped DOT to meet these targets for fiscal year 2017. Similarly, in the 2016 Strategic Sustainability Performance Plan, EPA emphasized that using alternative fuel in flex-fuel vehicles

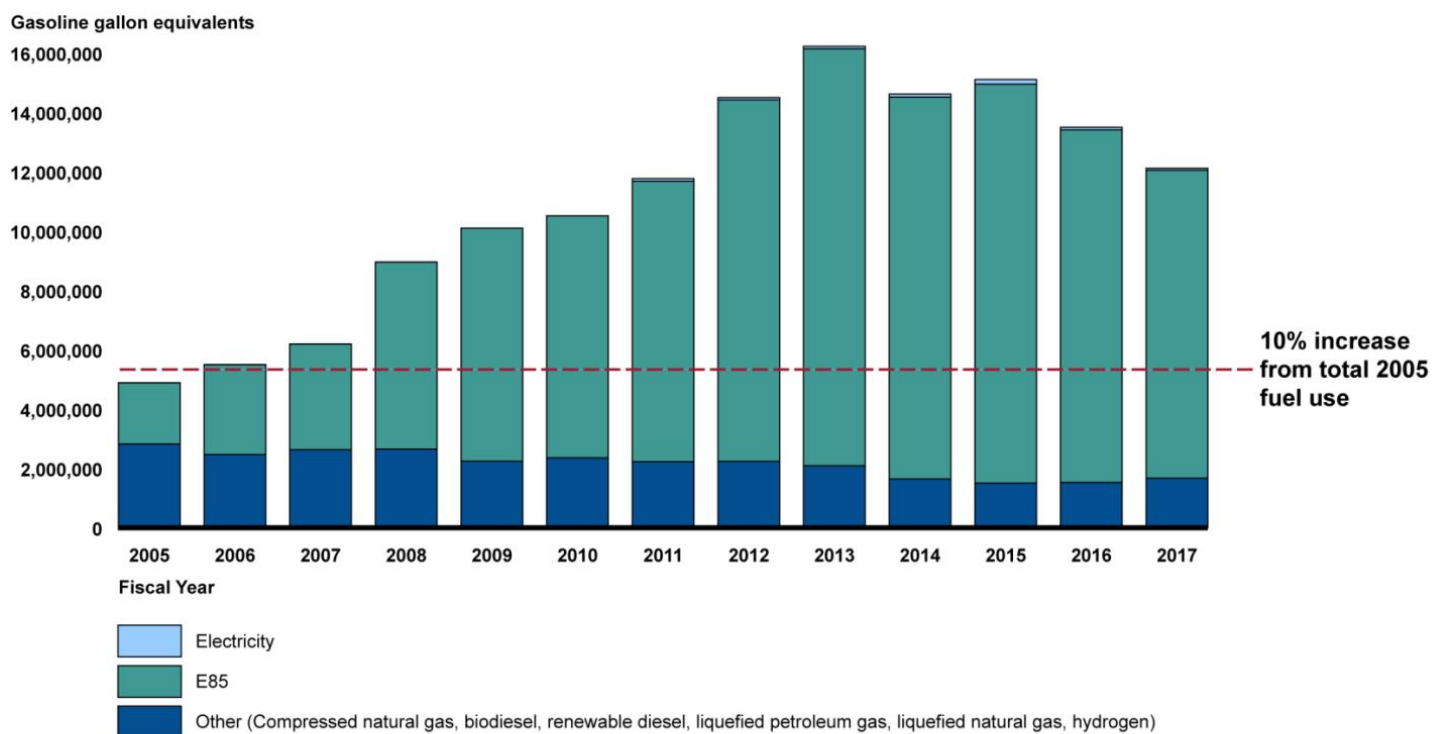
³⁶According to DOE guidance, agencies' vehicles' greenhouse gas emissions are measured based on emissions generated during driving the vehicles, known as tailpipe emissions. This calculation does not account for emissions created during the vehicle manufacturing or fuel production processes.

³⁷According to a 2015 DOE study, flex-fuel vehicles have become available in highly efficient models that even when operated only on gasoline achieve higher mile-per-gallon ratings than other traditional gasoline only models.

helped the agency reduce petroleum use. According to DOE officials, for agencies that met the fiscal year 2017 petroleum reduction target, about 11 percent of their petroleum reduction was due to using alternative fuel. According to DOE officials, the balance of petroleum reduction for these agencies was achieved through fuel efficiency improvements and behavioral changes, including reduction in vehicle miles traveled.

In spite of the emphasis some agencies put on alternative fuel use as part of their strategy to reduce petroleum use and greenhouse gas emissions, alternative fuel use in federal fleets overall has dropped in recent years. According to data reported in FAST, while alternative fuel use increased from 4.9-million gasoline gallon equivalents in fiscal year 2005 to 16.2-million gasoline gallon equivalents in fiscal year 2013, since fiscal year 2013 it declined to 12.1-million gasoline gallon equivalents in fiscal year 2017 (see fig.2). The fleet energy requirement to increase use of alternative fuel by 10 percent is based on a fiscal year 2005 baseline, and most agencies reported continuing to meet this requirement. In fact, as a whole, the federal government could continue to decrease its alternative fuel use by as much as 6.7 million gasoline gallon equivalents and still meet the targeted 10 percent increase above the fiscal year 2005 baseline. While E85 was the primary alternative fuel used, according to DOE data, alternative fuel use per dual-fueled vehicle is also at comparatively low levels—decreasing between fiscal years 2012 and 2016 from 123 to 90 gasoline gallon equivalents. This decrease was despite DOE’s reporting that the number of dual-fueled alternative fuel vehicles with access to alternative fuel increased from about 80,000 vehicles to about 112,000 over the same period. DOE officials said agencies could be using more alternative fuel, but suggested the recent decline could be due to a general lack of available E85 stations, among other reasons.

Figure 2: Total Alternative Fuel Use by All Federal Agencies Subject to Requirements to Increase the Use of Alternative Fuel, from Fiscal Year 2005 to 2017



Source: GAO analysis of Federal Automotive Statistical Tool data. | GAO-19-397

Data table for Figure 2: Total Alternative Fuel Use by All Federal Agencies Subject to Requirements to Increase the Use of Alternative Fuel, from Fiscal Year 2005 to 2017

Fiscal year	Electricity	E85	Other (Compressed natural gas, biodiesel, renewable diesel, liquefied petroleum gas, liquefied natural gas, and hydrogen)
2005	5,540	2,055,357	2,818,514
2006	5,464	3,030,754	2,460,114
2007	5,320	3,554,536	2,626,978
2008	4,363	6,297,621	2,645,817
2009	3,849	7,855,637	2,233,912
2010	33,270	8,153,903	2,351,302
2011	81,303	9,458,034	2,220,457
2012	79,690	12,178,078	2,230,640
2013	81,536	14,055,806	2,080,309

Fiscal year	Electricity	E85	Other (Compressed natural gas, biodiesel, renewable diesel, liquefied petroleum gas, liquefied natural gas, and hydrogen)
2014	101,656	12,866,034	1,640,123
2015	154,770	13,446,947	1,498,608
2016	84,546	11,886,854	1,519,318
2017	62,958	10,380,710	1,662,650

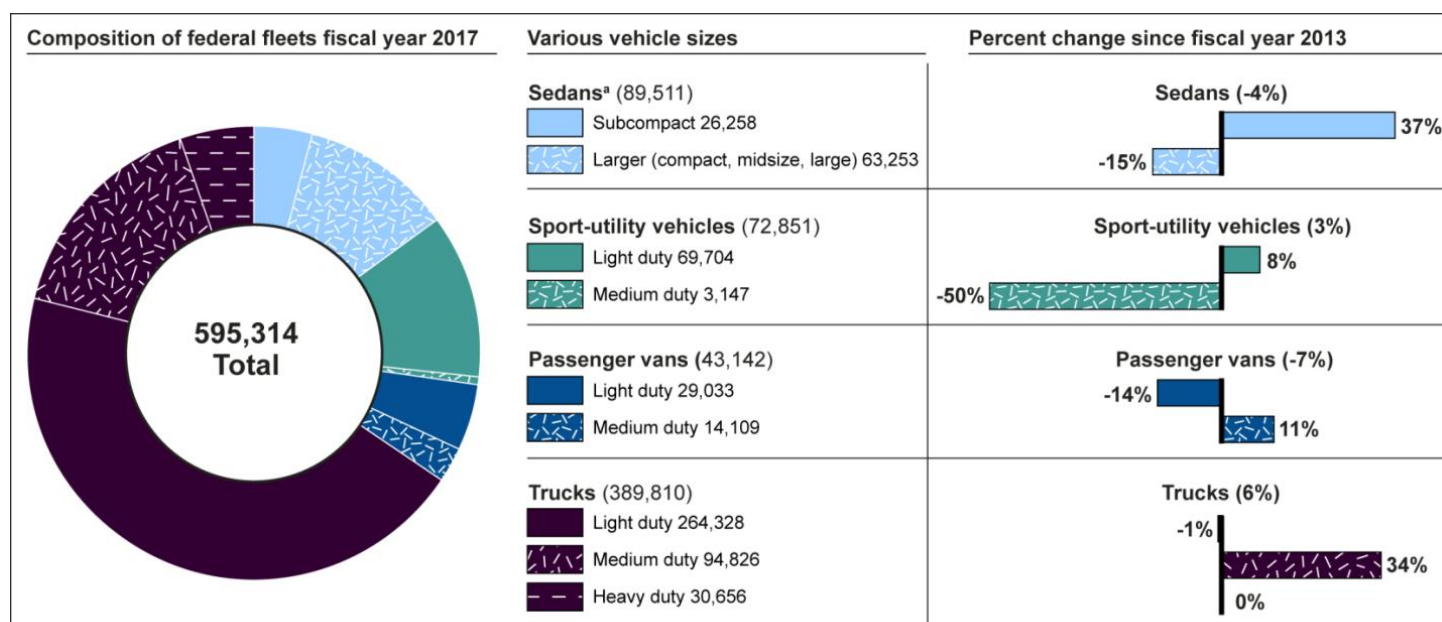
Improving Fleet Management

Fleet managers from all five case study agencies reported that their efforts to improve fleet management—even beyond those specifically related to acquiring alternative fuel vehicles—also helped them to reduce petroleum use and greenhouse gas emissions. Officials at several agencies reported in their Strategic Sustainability Performance Plans or told us that carrying out required fleet reviews helped them reduce the number of vehicles and change to more fuel-efficient vehicles, which directly helped them meet energy requirements. For example, EPA officials told us that through reviewing their vehicle usage, they identified which vehicles to either eliminate or replace with more efficient ones, moves that resulted in reducing petroleum use. Furthermore, in its 2017 Strategic Sustainability Performance Plan, EPA cited that it has reduced its fleet by 170 vehicles in the past 5 years and that its last study showed the potential to discontinue use of 80 to 100 vehicles in the next 5 years. Similarly, DOD reported in its fiscal year 2016 Strategic Sustainability Performance Plan that Army’s strategy to meet the requirement to reduce petroleum use was to reduce its fleet size and find the right mix of vehicles to meet its mission needs—in addition to acquiring fuel-efficient and alternative fuel vehicles. In this plan, Army reported that between fiscal year 2011 and fiscal year 2015, it reduced its fleet’s size by 16,400 vehicles.

According to GSA officials, at times, an agency may reduce its petroleum use and greenhouse gas emissions more by replacing large, inefficient vehicles (such as older, large trucks) with more efficient vehicles (such as new small trucks or sedans) even if both are fueled by gasoline—than by replacing an already highly efficient conventionally fueled small sedan with an alternative fuel vehicle of the same size. Our review of FAST data suggests that agencies were more successful in reducing the number and size of their sedans and size of their sport utility vehicles than in reducing the number or size of their larger vehicles, such as vans and trucks (see

fig. 3). For example, overall, the number of sedans in federal fleets fell by 4 percent from fiscal year 2013 to fiscal year 2017, with the number of larger sedans falling by 15 percent and the number of subcompact sedans increasing by 37 percent, suggesting that agencies moved to smaller, more efficient sedans.³⁸ On the other hand, among passenger vans, there was an increase in heavier, medium-duty passenger vans, and an overall increase in trucks was fueled by an increase in medium-duty trucks, while the number of light-duty trucks fell.

Figure 3: Composition of All Federal Agencies' Domestic Fleets by Various-Sized Vehicles, Fiscal Years 2013–2017



Source: GAO analysis of Federal Automotive Statistical Tool data. | GAO-19-397

³⁸For 2018, GSA offered larger sedans such as the Ford Taurus and small sedans such as the Ford Focus. According to GSA officials, the make and model of sedans offered varies from year to year.

Data Table for Figure 3: Composition of All Federal Agencies' Domestic Fleets by Various-Sized Vehicles, Fiscal Years 2013–2017

	Various vehicle type	Fiscal year 2017	Percent change since fiscal year 2013
Sedans	Subcompact	2,6258	37%
	Larger sedans (compact, midsize, large) total	63,253	-15%
	Sedan total	89,511	-4%
SUVs	Light Duty SUVs	69,704	8%
	Medium Duty SUVs	3,147	-50%
	SUVs total	72,851	3%
Passenger vans	Light Duty Passenger Vans	29,033	-14%
	Medium Duty Passenger Vans	14,109	11%
	Passenger vans total	43,142	-7%
Trucks	Light trucks total	264,328	-1%
	Medium Duty Trucks	94,826	34%
	Heavy Duty Trucks	30,656	0%
	Trucks total	389,810	6%
All vehicle total		595,314	3%

Note: The number of vehicles excludes low speed electric vehicles, limousines, ambulances, and buses.

^aThe category of sedans refers to sedans/station wagons. Most sedans are considered light-duty; however, there were 27 medium-duty sedans in 2017 used by agencies subject to the Energy Policy Act of 1992. For purposes of this analysis, "larger" sedans include compact, midsize and large vehicles and "smaller" sedans include subcompact vehicles.

In addition to reviewing and changing fleets, fleet managers also reported that encouraging certain driver behavior helped them to meet energy goals. According to VA's, Interior's, and EPA's fleet managers, agencies also reduced greenhouse gas emissions through educating or encouraging drivers to make behavioral changes such as reducing vehicle idling and overall miles traveled. For example, according to EPA fleet managers, certain regional offices have systems in place that facilitate their combining of motor pools and sharing trips to reduce petroleum use. As previously indicated, according to DOE officials, 11 percent of the reduction in petroleum use for agencies that met the petroleum reduction target was due to an increase in alternative fuel use. According to DOE officials, the balance of petroleum reduction for these agencies was achieved through fuel efficiency improvements and behavioral changes, including reduction in vehicle miles traveled.

Overall Composition of Federal Fleets Includes More Flex-Fuel Vehicles and Hybrids, and Electric Vehicle Numbers Remain Low

As a result of agencies' efforts to meet federal fleet energy requirements, the number of alternative fuel vehicles in federal fleets has grown steadily over the past 10 years, largely due to an increase in flex-fuel vehicles.³⁹

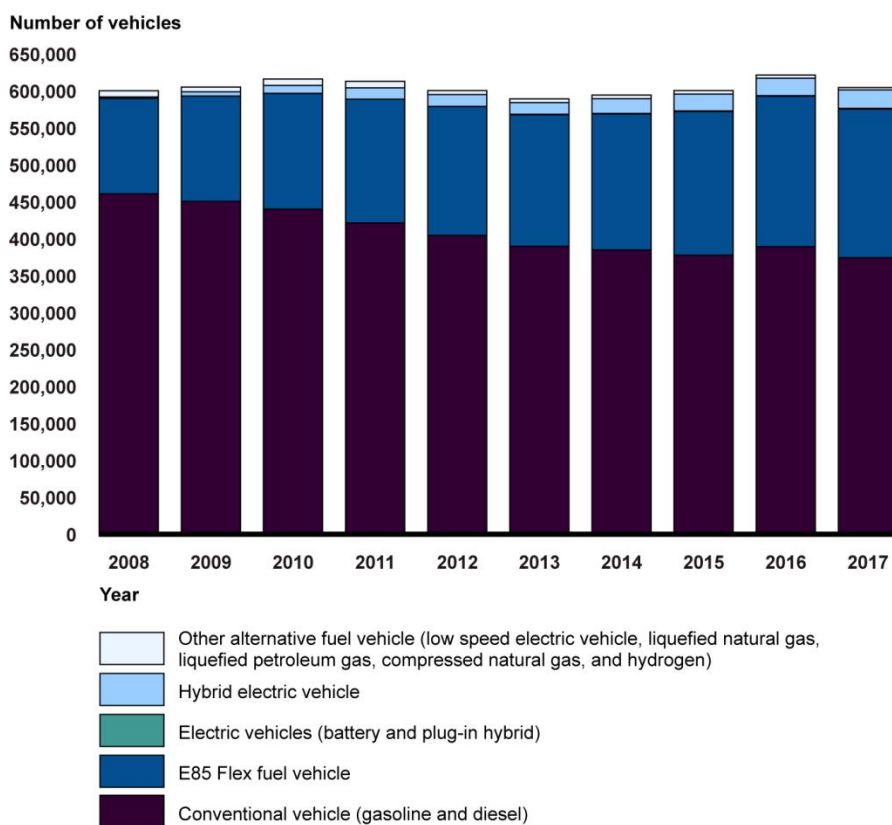
The number of alternative fuel vehicles in federal fleets increased by 65 percent from fiscal year 2008 through fiscal year 2017, according to FAST data (see fig. 4). During that same time, the number of conventional petroleum-fueled vehicles decreased by 19 percent. As a result, as of fiscal year 2017, alternative fuel vehicles made up about 38 percent of approximately 604,000 total domestic vehicles in the fleet.

Most of the alternative fuel vehicles in the federal fleets—about 87 percent in fiscal year 2017—are flex-fuel vehicles. As previously mentioned, while flex-fuel vehicles can contribute to reducing petroleum consumption when E85 is used, data show that the usage of E85 continues to fall (see fig. 2), thus reducing the potential environmental benefits of acquiring these vehicles. While the majority of flex-fuel vehicles offered to federal agencies by GSA in fiscal year 2017 did not cost more for agencies to acquire than equivalent petroleum-fueled vehicles, some flex fuel vehicles did cost more for agencies to acquire, with, for example, a few sport-utility flex-fuel vehicles costing between \$4,000 and \$7,000 more than comparable vehicles. Within the past decade, the number of hybrid vehicles in federal fleets also increased significantly, from almost 1,800 in fiscal year 2008 to over 25,000 in fiscal year 2017. Hybrids accounted for about 11 percent of all alternative fuel vehicles in fiscal year 2017. Finally, while agencies have acquired some electric vehicles, the number of electric vehicles in federal fleets has

³⁹FAST has tracked low greenhouse gas vehicles and whether they qualify as alternative fuel acquisitions since they began to be considered as such. However, it only tracks them as acquisitions in a specific year for the purposes of meeting alternative fuel vehicle acquisition requirements. It does not track their numbers within an agency's entire inventory.

remained very small—consisting of just over 1,000 plug-in hybrid electric and battery electric vehicles in fiscal year 2017.⁴⁰

Figure 4: Total Numbers of All Domestic Alternative Fuel Vehicles for Federal Agencies Subject to the Energy Policy Act of 1992, by Type, for Fiscal Years 2008 through 2017



Source: GAO analysis of Federal Automotive Statistical Tool data. | GAO-19-397

⁴⁰This excludes low-speed electric vehicles. While the make and model of vehicles that GSA offers can vary from year to year, in fiscal year 2017, for battery electric vehicles, GSA offered the Ford Focus, Nissan Leaf, and GM Bolt; for plug-in hybrid electric vehicles, GSA offered the Sonata plug-in hybrid, the Ford Fusion, the Ford C-Max, the GM Volt, and the Pacifica plug-in hybrid; and for hybrid electric vehicles, GSA offered the Ford Fusion, Sonata Hybrid, Ford CMAX, GM Malibu, and one light-duty shuttle.

Data table for Figure 4: Total Numbers of All Domestic Alternative Fuel Vehicles for Federal Agencies Subject to the Energy Policy Act of 1992, by Type, for Fiscal Years 2008 through 2017

Fiscal year	Conventional vehicle	E85 Flex fuel vehicle	electric vehicle (battery and plug-in hybrid)	Hybrid electric vehicle	Other alternative fuel vehicle (low speed electric vehicle, liquefied natural gas, liquefied petroleum gas, compressed natural gas, and hydrogen)
2008	460,618	129,251	83	1,766	8,448
2009	450,458	142,501	56	5,574	6,679
2010	439,867	156,689	71	10,621	8,732
2011	421,247	167,450	65	15,412	8,865
2012	404,318	174,469	240	15,883	5,495
2013	389,629	177,991	625	15,834	5,139
2014	384,676	184,042	678	19,887	5,096
2015	377,703	194,210	897	22,863	4,813
2016	389,254	203,497	791	23,519	4,270
2017	374,284	200,950	1,055	25,059	3,150

Several Challenges May Limit Further Progress toward Fleet Energy Goals

In spite of federal agencies' reported general success in meeting fleet energy requirements, several challenges may hinder agencies' further progress towards the goals of reducing federal fleets' petroleum use and greenhouse gas emissions. First, although acquiring electric and hybrid vehicles could help agencies meet the current fleet energy goals to reduce petroleum use and per-mile greenhouse gas emissions in federal fleets, depending on where and how the vehicles are used, costs can be prohibitive. The costs of these vehicles and charging infrastructure make it challenging for agencies to acquire them on a large scale. Second, a lack of fuel and infrastructure availability limits agencies use of alternative fuel, specifically E85. Third, agency officials we interviewed stated that a continuing need for larger vehicles to perform certain tasks limits the number of low greenhouse gas vehicles agencies can acquire—and thus the potential to reduce petroleum use and greenhouse gas emissions.

Higher Costs Pose Challenges to Acquiring Electric and Hybrid Vehicles

Acquiring electric and hybrid vehicles could help agencies meet fleet energy goals, but higher costs pose challenges. As described previously, prior to May 2018, federal agencies were under a directive to acquire zero-emission (electric) and plug-in hybrid electric vehicles for 20 percent of all new agency passenger vehicle acquisitions by December 31, 2020, and for 50 percent by December 31, 2025. Some of the discussions we had with agency officials about challenges related to acquiring electric vehicles took place while this directive was in effect.⁴¹ In part because guidance on the new Executive Order had not been issued at the time we spoke with them (although it was subsequently issued in April 2019), agency officials we spoke with after this directive was revoked said they were uncertain of the effect of the new Executive Order and would continue to try and meet fleet energy goals until new guidance was issued.

Compared to other alternative fuel vehicles available from GSA, battery electric, plug-in hybrid electric, and hybrid electric vehicles can offer potential to further general federal goals to reduce petroleum use and tailpipe greenhouse gas emissions.⁴² Specifically, battery electric vehicles consume no petroleum and produce zero tailpipe greenhouse gas emissions, while plug-in hybrid electric vehicles have the potential to consume very little gasoline, with a correspondingly small amount of tailpipe greenhouse gas emissions from the gasoline used, and hybrid electric vehicles offer higher fuel economy than many other vehicles.⁴³ According to DOE's *Fleet Management Handbook*, replacing a petroleum-fueled vehicle with a battery electric vehicle provides a 100 percent

⁴¹In addition, our survey of federal agencies took place prior to the Executive Order being revoked.

⁴²As previously discussed, fleet management can also help reduce petroleum use and greenhouse gas emissions. For example, GSA officials told us agencies can also effectively reduce petroleum and greenhouse gas emissions by replacing their oldest and least efficient vehicles with newer, more efficient models.

⁴³Plug-in hybrid electric vehicles can operate in electric-only mode or via gasoline. They produce no tailpipe emissions when in electric-only mode, and, as long as the battery is charged, these vehicles can draw most of their power from electricity during typical urban driving—leading to low consumption of gasoline. In addition, even when operating in hybrid mode and consuming both gasoline and regenerated electricity, the fuel economy of plug-in hybrid electric vehicles is relatively high compared to conventional gasoline powered vehicles.

reduction in that vehicle's use of petroleum. In addition, according to DOE officials, for purposes of tracking agencies' compliance with the now-revoked Executive Order's fleet requirements, battery electric vehicles were considered emissions free, and plug-in hybrids were considered emissions free when run on electricity.

The now-revoked fleet requirements did not consider emissions generated during the production of fuel or the manufacturing process. The Council on Environmental Quality guidance states that emissions generated from the production of electricity are not counted toward agencies' fleet emissions because those emissions are assumed to be captured in each agency's facility electricity reporting and their annual greenhouse gas data report. Counting them as fleet emissions would result in double counting. Nevertheless, to fully consider the potential environmental benefits of alternative fuel vehicles, these emissions would need to be considered and compared to the emissions generated by the production of fuel and manufacturing process of conventionally fueled vehicles.

From a full life-cycle perspective, greenhouse gases emitted during the manufacturing of a vehicle affect a vehicle's overall emissions. Accurately determining the amount of greenhouse gas emitted during the manufacturing of different types of vehicles is complicated, and we found no federal source that publishes this information. However, a study by the International Energy Agency found that manufacturing battery electric vehicles results in higher greenhouse gas emissions than manufacturing conventional internal combustion engine gasoline-fueled vehicles—but that over the typical life of an electric vehicle, the elimination of tailpipe emissions results in these vehicles having lower greenhouse gas emissions overall than conventional gasoline-fueled vehicles, with the amount of emissions savings depending on the carbon intensity of power generation used to charge the vehicles.⁴⁴ Another study, by Argonne National Laboratory, considered mid-size light-duty vehicles.⁴⁵ According to this study, on a life-cycle basis—including emissions related to the manufacture and disposal of the vehicles, the production of the fuel, and

⁴⁴International Energy Agency, *Global EV Outlook 2018*.

⁴⁵Elgowainy, Amgad, Jeongwoo Hann, Jacob Ward, Fred Joseck, et. al, *Cradle-to-grave Lifecycle Analysis of U.S. Light-Duty Vehicle Fuel Pathways: A Greenhouse Gas Emissions and Economic Assessment of Current (2015) and Future (2025-2030) Technologies*, Argonne National Laboratory (September 2016). Argonne National Laboratory is a DOE laboratory.

the use of fuel to operate the vehicle—hybrid electric vehicles produced about 25 percent fewer greenhouse gas emissions per mile than conventionally fueled gasoline vehicles, plug-in hybrid electric vehicles produced about 26 to 29 percent fewer greenhouse gas emissions per mile than conventionally fueled gasoline vehicles, and battery electric vehicles produced about 26 to 34 percent fewer greenhouse gas emissions per mile. The study also considered the life-cycle greenhouse gas emissions for flex fuel vehicles run on E85, finding them to produce about 20 percent fewer greenhouse gas emissions per mile than a conventionally fueled gasoline vehicle.

This study also considered the costs of alternative fuel vehicles in light of their potential to reduce greenhouse gas emissions. It estimated that in 2013 dollars and, based on high volume production, a 15-year vehicle life-cycle, and a 5 percent discount rate, the greenhouse gas emissions avoided by using hybrid-electric vehicles compared to a conventional gasoline fueled vehicle cost \$240 per metric ton. For plug-in hybrid electric vehicles, the cost is between \$390 and \$860 per metric ton of greenhouse gas emissions avoided, and for battery electric vehicles the cost is from \$1,090 to \$2,600 per metric ton of greenhouse gas emissions avoided. For flex fuel vehicles, the cost was estimated to be \$170 per metric ton of greenhouse gas emissions saved.

Based on these findings, when an agency replaces a petroleum fueled vehicle with a battery electric vehicle, a plug-in hybrid electric vehicle, or a hybrid electric vehicle, it can reduce its petroleum use and greenhouse gas emissions, though the extent of its reduction depends on the type of vehicle the agency acquires, and the type of vehicle it replaces, as well as many other factors. However, it may currently be paying more for such vehicles from a life-cycle perspective. In the time since this study was published, according to DOE, battery costs have continued to fall, and these vehicles may be cost competitive in the near future.

For battery-electric vehicles and plug-in hybrid electric vehicles, which must be regularly charged from the electrical grid, one consideration included in the Argonne National Lab study's analysis of how much greenhouse gasses are emitted through the vehicle's operation is the level of greenhouse gas emissions associated with electricity generation. Such emissions affect the extent to which using electricity instead of gasoline to fuel vehicles reduces the amount of greenhouse gas emissions generated into the atmosphere—and this varies by location. While the Argonne National lab study described above based its analysis on the average mix of electrical generation in the U.S., the amount of

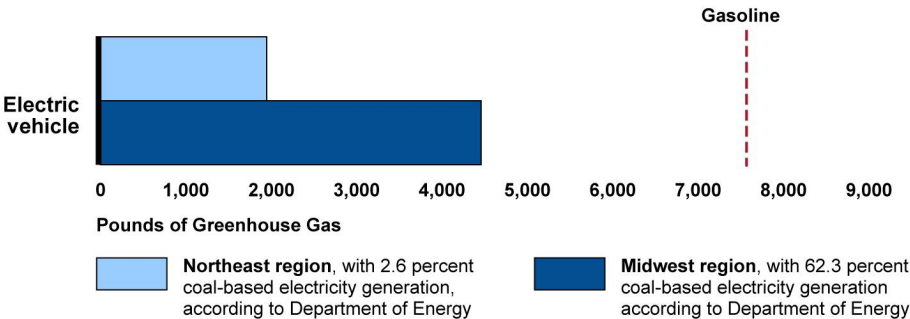
greenhouse gas emissions associated with electricity generation in the U.S. actually varies widely depending on the sources used to generate the electricity. These sources vary depending on the region of the country where the electricity is produced.⁴⁶

For example, the production of electricity from burning coal causes relatively high greenhouse gas emissions, while the production of electricity from solar or wind causes little to no greenhouse gas emissions. As a result, a battery electric vehicle charged in a region with low coal electricity generation, such as the Northeast—whose electricity generation mix includes about 2.6 percent coal—will result in greater greenhouse gas emissions reductions than those charged in regions where most electricity generation comes from coal, such as the upper Midwest, which uses about 62.3 percent coal (see fig. 5).⁴⁷ These figures are meant to illustrate the differences in electricity generation, and they do not account for other factors that may affect vehicles' efficiency and thus the extent to which they lead to reductions in emissions. For example, in extreme weather conditions, the range of battery-electric vehicles can be reduced, resulting in more frequent charging, and thus more electricity use. Further, the use of air conditioning or other components in the vehicle can also impact their fuel efficiency. We analyzed emissions data on vehicles operating in different parts of the country and found that when considering both tailpipe and fuel-production greenhouse gas emissions, electric and plug-in hybrid electric vehicles produce less greenhouse gas emissions than an equivalent gasoline-only vehicle in both higher-coal and lower-coal electricity generation regions. In higher-coal electricity generation regions, however, electric vehicles can offer less or about an equivalent reduction in greenhouse gas emissions to comparably-sized hybrid electric vehicles, whereas in lower-coal electricity generation regions, electric vehicles offer the opportunity to reduce greenhouse gas emissions by a greater extent than comparably-sized hybrid electric vehicles.

⁴⁶According to DOE, the greenhouse gas emissions associated with using gasoline are generally consistent across the country.

⁴⁷The actual emission-reduction benefits of battery electric and plug-in hybrid electric vehicles, according to a 2016 National Renewable Energy Laboratory report, are dependent on multiple factors, such as the electricity generation fuel mix, time of day charging, and vehicle type.

Figure 5: Estimated Annual Greenhouse Gas Emissions (Tailpipe and Production of Fuel) of Selected Subcompact Sedans Driven in Regions That Do or Do Not Depend Heavily on Coal for Electricity Generation



Source: GAO analysis of Department of Energy data. | GAO-19-397

Data table for Figure 5: Estimated Annual Greenhouse Gas Emissions (Tailpipe and Production of Fuel) of Selected Subcompact Sedans Driven in Regions That Do or Do Not Depend Heavily on Coal for Electricity Generation

	Northeast region, with 2.6 percent coal-based electricity generation, according to Department of Energy	Midwest region, with 62.3 percent coal-based electricity generation according to Department of Energy
Battery Electric	1,946.26 pounds of greenhouse gas	4,458.88 pounds of greenhouse gas

Note: We selected subcompact sedans—specifically, a battery electric, a plug-in hybrid electric, and a conventional vehicle—designated as low greenhouse-gas-emitting and available to federal agencies through the General Services Administration’s fiscal year 2017 product guide. The analysis compares total annual tailpipe and fuel-production emissions assuming each vehicle travels 9,438 miles per year—the average miles traveled for a federally owned or leased sedan—50 weeks per year for 5 days a week; thus, 37.75 miles per day. This analysis does not include the emissions generated from the vehicle manufacturing process, and it does not account for variations in electricity production emissions that can occur from the time of day of fuel use

In 2009, we recommended that DOE develop guidance to help agencies plan to acquire the right mix of vehicles that can meet requirements while also taking into account the energy sources used to generate the electricity used to fuel electric vehicles. In response, DOE issued guidance that recommended agencies consider, among other things, whether coal-based electricity is used in an area in order to evaluate the location and emissions-reduction potential of using such vehicles. However, of the five case study agencies we spoke to, no agency officials said that they specifically worked to locate electric vehicles where the production of electricity was likely to produce fewer greenhouse gases. Since greenhouse gas emissions due to the production of electricity were not considered in the now-revoked executive order’s requirements and, according to the case study agency officials, was not stressed by GSA in discussions about increasing electric vehicles, they stated that this had not been a focus of their efforts. Instead, they stated that they focused on

locating electric vehicles where they were able to install electric charging stations and had a mission need that fit with the use of electric vehicles.

According to some agency officials, the higher acquisition costs associated with electric vehicles and the costs of installing charging infrastructure have hindered the extent of their integration into federal fleets. (See app. III for a more detailed discussion of life-cycle costs of electric vehicles.) As part of an effort to further the overall goal of reducing greenhouse gas emissions, the now-revoked 2015 Executive Order called for agencies to increase their acquisition of zero-emission vehicles (battery-electric vehicles) or plug-in hybrid electric vehicles by 2020.⁴⁸ While all five case study agencies had acquired small numbers of electric vehicles and associated charging infrastructure, two fleet managers said that the cost challenges would have made it difficult to acquire sufficient numbers of vehicles to meet the Executive Order's requirements by 2020, had the Executive Order not been revoked.

To meet the revoked electric-vehicle acquisition requirements, federal agencies would have had to acquire close to 3,000 battery electric or plug-in hybrid electric vehicles per year starting in 2020, according to GSA officials. According to data provided by GSA, in fiscal year 2017, agencies purchased 373 battery electric or plug-in hybrid electric vehicles. Just over half of these vehicles were plug-in hybrid electric minivans, with the rest being sedans.⁴⁹ The purchase of these 373 battery electric or plug in hybrid electric vehicles, plus an additional 4,584 hybrid electric sedans, made up about 31 percent of the just over 16,000 sedans and minivans acquired that year—and increased the total amount agencies spent purchasing sedans and minivans by about \$10.5 million (see table 3)—or about 3 percent of the total of approximately \$314 million spent purchasing sedans and minivans overall.⁵⁰ Among the hybrid

⁴⁸The Executive Order required agencies to acquire zero emission vehicles (battery electric vehicles) or plug-in hybrid vehicles for 20 percent of all new agency passenger vehicle acquisitions by fiscal year 2020, and for 50 percent by fiscal year 2025.

⁴⁹All of the battery electric and plug-in hybrid electric vehicles GSA offered agencies for purchase or lease in fiscal year 2017 were either sedans or minivans. Vehicles GSA acquired to lease to other agencies are included in this purchasing data because GSA provides leasing services to federal agencies.

⁵⁰The hybrid electric vehicles would not have counted towards the acquisitions requirement of the revoked executive order, but agencies could have counted them toward the requirement to acquire alternative fuel vehicles, and they may help agencies to reduce agencies petroleum use and per-mile tailpipe greenhouse gas emissions.

electric, battery electric, and plug-in hybrid electric sedans and minivans, federal agencies purchased the largest numbers of hybrid-electric sedans, which had the smallest additional average per-vehicle costs as compared to comparably sized gasoline or flex-fueled vehicles. As a result, agencies spent an average amount of about \$2,000 more per battery electric, plug-in hybrid electric, and hybrid electric vehicle acquired, although the average amount per vehicle varied widely by size and type of vehicle acquired. As described below, some of the higher acquisitions costs of these alternative fuel vehicles will be recovered due to lower maintenance and fuel costs of the vehicles over time. However, we were unable to get data on federal agencies' actual lifecycle costs of these vehicles because, according to agency officials, agencies had not tracked these data consistently.

Table 3: Costs of Selected Passenger Vehicles Purchased by Federal Agencies, Fiscal Year 2017

Type of vehicle purchased	Vehicle size	Number of vehicles	Total cost (in dollars)	Average cost per vehicle (in dollars)	Average additional cost per vehicle acquired compared to similar gasoline or flex fueled vehicle ^a (in dollars)	Total additional costs compared to similar gasoline and flex fueled vehicles ^b (in dollars)
Hybrid-electric sedans	Subcompact	1,018	19,999,828	19,646	5,228	5,322,294
	Compact	3,566	67,620,461	18,963	122	434,161
Plug-in hybrid electric sedans	Subcompact	40	1,117,200	27,930	13,512	540,479
	Compact	61	1,682,601	27,584	8,743	533,312
	Minivan	191	7,187,542	37,631	15,381	2,937,741
Battery electric sedans	Subcompact	81	1,889,153	23,323 ^c	8,905	721,294
Totals		4,957	99,496,785	20,072	2,116	10,489,283

Source: GAO analysis of General Services Administration's (GSA) vehicle purchase data. | GAO-19-397

^aThis column identifies the average cost paid above the average cost for a comparably sized vehicle that is gasoline or flex-fueled, according to the same GSA-provided data. The GSA-provided data on purchased vehicles did not distinguish between gasoline and flex-fueled vehicles; therefore, we were not able to separate out costs of these two types of vehicles.

^bThis column identifies the total costs paid above the total costs that agencies would have paid if they had purchased same number of comparably sized vehicles at the average price of the gasoline and flex-fueled vehicles, according to the same GSA-provided data. The GSA-provided data did not distinguish between gasoline and flex-fueled vehicles; therefore, we were not able to separate out the costs of these two types of vehicles.

^cIn 2017, GSA negotiated a special rate for a Ford Focus battery electric vehicle of \$16,160 that contributed to this low average price. That year GSA also offered the Nissan Leaf and Chevrolet Bolt, which sold for \$20,076 and \$34,811, respectively.

Of the 29 agencies we surveyed, 11 identified acquisition costs as a challenge to acquiring and using electric vehicles. In addition, 20 of the 29 agencies identified charging infrastructure as a key challenge to acquiring electric vehicles, citing the costs of installation among other challenges.

In discussions with case study agencies, federal officials did not cite the acquisition costs of flex-fuel vehicles as a challenge to acquiring these vehicles. Some officials stated that these vehicles' relatively low costs compared to other alternative fuel vehicle options was one reason that agencies have largely met the alternative fuel vehicle acquisitions requirement through the acquisition of flex fuel vehicles. GSA's purchasing data did not provide sufficient detail for us to analyze the extent to which agencies paid more to purchase flex fuel vehicles. According to GSA's leasing data on GSA-leased vehicles, for fiscal year 2017, agencies acquired over 20,600 alternative fuel vehicles, of which over 14,700 were flex fuel vehicles leased at no additional cost.⁵¹ However, agencies also acquired 1,268 flex fuel vehicles that, on average, had an additional cost of about \$2,300, with the result that agencies spent a total of about \$2.9 million more to acquire these vehicles to lease than if they had acquired equivalent gasoline-fueled vehicles.

When agencies choose to lease an alternative-fuel vehicle that is more expensive than a comparable conventionally fueled vehicle, under law, GSA must spread that difference in cost—sometimes referred to as the incremental cost—across the agency's entire fleet during the year the alternative fuel vehicle is acquired.⁵² According to GSA officials, this requirement makes it easier for agencies to incorporate higher-priced alternative fuel vehicles, such as battery-electric or plug-in hybrid electric vehicles, into their fleets. The difference in cost between acquiring a plug-in hybrid electric or battery-electric vehicle compared to an equivalently sized conventionally fueled vehicle can vary depending on the amount GSA has negotiated with the dealer to pay for a particular vehicle. For example, GSA's lease offerings showed that for fiscal year 2019, agencies would have to pay anywhere from about \$5,300 to \$19,400 more to acquire a plug-in hybrid electric vehicle than to acquire an

⁵¹This does not include agency-owned and commercially leased vehicles.

⁵²42 U.S.C. § 13212(c). As of fiscal year 2018, about 85 percent of all battery-electric and plug-in hybrid electric vehicles in federal fleets were leased from GSA. GSA covers acquisition, maintenance, and fuel costs of its leased vehicles, and is required to recover all costs it incurs through charges to the agency lessees. See 40 U.S.C. § 605(b).

equivalently sized conventionally fueled vehicle, and approximately \$16,100 to \$18,800 more to acquire a battery electric vehicle that is an equivalently sized conventionally-fueled vehicle.⁵³ Officials from two case study agencies told us that because GSA spreads the additional costs over an agency's entire leased fleet, the costs may not affect the agency's budget much as long as the agency acquires only a small number of vehicles. For example, according to a local DOT official, the acquisition of two battery-electric Ford Focuses added an additional \$15 per vehicle to each of its vehicles in its fleet.

While electric vehicles have higher acquisition costs, they generally have lower fuel and maintenance costs than conventionally fueled vehicles, and as a result, GSA officials charge agencies lower mileage rates for these vehicles. GSA also charges agencies lower mileage rates for hybrid vehicles, based on their higher fuel efficiency. Of the agencies we surveyed, 14 of the 29 identified lower fuel and maintenance costs as a key benefit to acquiring battery electric or plug-in hybrid electric vehicles. Because of these lower mileage rates, the more miles an agency drives a leased electric vehicle, the more the overall cost difference to the agency between an electric vehicle and a conventionally fueled vehicle will shrink. However, our analysis of GSA's leasing rates showed that over 5 years—the typical life of a lease of an electric vehicle—and with average mileage—these lower mileage costs would not make up for the higher acquisition costs of these vehicles (see fig. 6).⁵⁴ GSA officials and several fleet managers also told us that in their experiences with leasing electric vehicles, lower utilization coupled with the lower mileage costs charged by GSA to agencies had not made up for the significantly higher acquisition cost over the life of the leases. The GSA lease costs consider the lifetime costs of the vehicles, including fueling and maintenance and

⁵³GSA determines these price differentials based on the price of a similar model in the same vehicle class that is conventionally fueled—i.e., by gasoline per Energy Policy Act of 2005 implementing guidance. According to GSA, the Alternative Fuel Guide that identifies available alternative fuel vehicles and their prices is updated throughout the year when new vehicles become available. We accessed the Alternative Fuel Guide on July 19, 2019.

⁵⁴Electric vehicles generally require less maintenance, in part, because brake wear is significantly reduced due to regenerative braking and the electrical system (battery, motor, and associated electronics) typically requires little to no maintenance. Regarding fuel costs, according to GSA, the cost of the electricity used is paid by the agencies and not GSA, and therefore, it is not included in the mileage rate GSA charges agencies. This is typically part of the agencies' facilities electrical use, and therefore the agency pays for this as part of the bill for electricity for the facility. However, these costs are generally lower than the fuel costs than for a similar conventional vehicle.

eventual disposal of the vehicle through auction. The five case study agencies we spoke with did not use a life-cycle analysis to compare costs across various vehicle types when making vehicle procurement decisions. However, all five case study agencies told us they analyze life-cycle costs to inform their lease versus purchase decisions. See appendix III for more discussion on life-cycle costs.

Figure 6: Estimated Costs of Selected Subcompact Vehicles Paid to General Services Administration over a 5 Year Lease, Fiscal Year 2019

Vehicle type	Difference in acquisition cost compared to conventionally fueled vehicle ^a	Monthly cost	Mileage ^b	Estimated total costs over a 5 year period ^c
Battery electric vehicle	+\$18,811	\$195	 5.4 cents/mi	 \$33,060
Plug-in hybrid electric vehicle	+\$7,902	\$195	 8.8 cents/mi	 \$23,755
Hybrid electric vehicle	+\$5,566	\$185	 10.7 cents/mi	 \$21,715
Conventional vehicle	\$0	\$185	 12.3 cents/mi	 \$16,904

Source: GAO analysis of General Services Administration data. | GAO-19-397

Data table for Figure 6: Estimated Costs of Selected Subcompact Vehicles Paid to General Services Administration over a 5 Year Lease, Fiscal Year 2019

Vehicle type	Difference in acquisition cost compared to conventionally fueled vehicle ^a	Monthly cost	Mileage ^b	Estimated total costs over a 5 year period ^c
Battery electric vehicle	+\$18,811	\$195	5.4 cents/mi	\$33,060
Plug-in hybrid electric vehicle	+\$7,902	\$195	8.8 cents/mi	\$23,755
Hybrid electric vehicle	+\$5,566	\$185	10.7 cents/mi	\$21,715
Conventional vehicle	\$0	\$185	12.3 cents/mi	\$16,904

Note: For fiscal year 2019, GSA's Alternative Fuel Vehicle Guide's options for subcompact vehicles included hybrid electric vehicles, battery electric vehicles, plug-in hybrid electric vehicles, and conventionally fueled (gasoline) vehicles. It did not include any subcompact flex-fuel vehicles. As a result, we did not include a flex-fuel vehicle as part of this analysis.

^aGSA must spread this difference in cost—sometimes referred to as the incremental cost—across the agency's entire fleet during the year the alternative fuel vehicle is acquired.

^bMileage rate includes the fuel costs for gasoline or E85. It does not include fuel costs of electricity, which agencies pay for separately, typically through their general facilities electric bill.

^cEstimated total cost assumes the vehicle is driven an average of 9,438 miles per year—the average miles travelled for a federally owned or leased sedan.

Fleet managers at three of the case study agencies we spoke with before the Executive Order was revoked told us that they had worked to increase the number of electric vehicles in their fleets, in spite of the higher costs. Officials at a few agencies stated that when the budget allowed, they would try to acquire electric vehicles. For example, VA officials told us that VA budgets for electric vehicles on the local level, and that local staff decide how much of their budget will go towards funding of electric vehicles. VA and Interior officials said their acquisitions of electric vehicles had thus far not greatly affected their budgets, but within Interior, the fleet managers for Fish and Wildlife Services and the Bureau of Indian Affairs said cost could become an issue if more electric vehicles were to be acquired. GSA Office of Governmentwide Policy officials told us that agencies could fit the higher costs of acquiring electric vehicles into their budget by reducing their fleet size and acquiring a few of these more expensive vehicles. Further, GSA has introduced several initiatives to help agencies finance alternative fuel vehicle acquisitions, including specific electric vehicle initiatives. For example, in fiscal year 2016, according to an Army fleet manager, Army acquired electric vehicles through GSA at a price GSA had negotiated that was equal to the price for comparably sized petroleum fueled vehicles. However, this pricing was only offered in 2016 as part of a one-time deal that GSA negotiated with the vehicle manufacturer.

In addition to the costs of purchasing or leasing electric vehicles, agencies described challenges balancing the costs of purchasing and installing charging stations with other competing priorities.⁵⁵ Agency officials told us they generally prefer charging stations, such as Level 2

⁵⁵Three charging options typically exist: AC Level 1, AC Level 2, and DC fast charging station. According to DOE, using a Level 1 charging station provides 2 to 5 miles of range per hour charged and requires no additional infrastructure. A Level 2 charging station can provide 10 to 20 miles of range per hour charged and requires the installation of additional support equipment. A DC Fast Charging station can provide 50 to 70 miles of range in less than 20 minutes and also requires the installation of additional support equipment.

stations, that can charge a vehicle in a few hours to allow vehicles to be used multiple times a day.⁵⁶ These types of Level 2 charging stations can cost anywhere from about \$400 to \$8,000 depending on the model and its features and do not include installation costs.⁵⁷ Generally, the less expensive models may not include features such as energy monitoring that tracks electricity use or communication capabilities that enables data communication that some fleet managers said they view as necessary to manage and track the performance and costs of electric vehicles.⁵⁸ We were unable to determine the total amount that agencies had spent to acquire existing charging stations to date because data were not available at a sufficient level of detail.

Installation costs also varied widely, depending, among other things, on the complexity of the installation, such as the need for trenching or upgrading the electrical service. For example, officials from VA told us that sometimes in order to install charging stations, they have had to trench an entire parking lot to ensure the units have the necessary power to charge its vehicles—which can be expensive. DOE estimates that to install a charging station it costs about \$100 per foot to trench through concrete, lay conduit, and refill. As a result, it could cost up to \$10,000 to trench 100 feet. Further, the Veterans Health Administration indicated that funding for purchasing and installing charging stations at their facilities had to compete with other priorities. Specifically, the costs for charging stations came out of the facilities' capital-planning budget, which also includes funding for veterans' care. Similar to determining what agencies have spent on charging stations, we were also unable to determine what total installation costs have been to date because of data limitations.

Although many federal facilities are not equipped with fast charging infrastructure and the number of public charging stations remains limited, federal agencies had begun taking steps to install more charging stations.⁵⁹ Prior to the 2015 Executive Order being revoked, agencies had

⁵⁶These agency officials consistently stated that they preferred at least level 2 charging stations.

⁵⁷The price reflects different features available for the Level 2 charging stations. Such features include, tracking and reporting on amount of electricity used, advanced display features, and multiple plugs per charging station.

⁵⁸Army officials stated that electric vehicles with telematics capable of tracking such information will be available through GSA, and as a result, they did not place a priority on the ability of charging stations to do so.

⁵⁹Our analysis only considered Level 2 and DC fast-charging stations.

recently begun to install more of these stations as part of their efforts to prepare for the requirement that 20 percent of light-duty vehicle acquisitions be zero emission (electric) vehicles or plug-in hybrid vehicles by 2020. We found 12 out of the 29 agencies we surveyed had installed more than 20 charging stations, while 14 others had installed at least one charging station, and only 3 agencies had not installed any charging stations. According to past Strategic Sustainability Performance Plans, agencies had started to implement strategies to increase their electric-vehicle infrastructure. For example, according to EPA's fiscal year 2016 plan, it planned to conduct a survey of its parking facilities to develop a charging infrastructure policy and plan, including identifying potential locations for charging stations. Similarly, Army officials described taking additional steps, including sending specialized teams to several of its bases to determine the optimal and least costly placement of its charging stations. However, fleet managers also told us they were having difficulties installing electric vehicle infrastructure, in particular at leased facilities. Specifically, several agencies' fleet managers told us that it was difficult or impossible to install charging stations at leased properties unless their installation was negotiated into the lease from the beginning. In part because guidance on the new Executive Order had not been issued at the time we last spoke with agency officials on this issue, the extent to which the revoking of the directive related to acquiring electric vehicles would affect agencies' efforts to install charging infrastructure was unclear.

Availability Limits Agencies' Use of Alternative Fuel

Fleet managers told us that another challenge that may limit progress toward energy goals was a lack of fuel availability—in particular the availability of E85—which made it difficult to fuel flex-fuel vehicles with alternative fuel.⁶⁰ Of the 29 agencies, 20 identified the availability of E85 as a challenge to using alternative fuel in flex-fuel vehicles. While some agencies still largely rely on flex-fuel vehicles to meet alternative fuel vehicle acquisition requirements, E85 can only be found at about 2 percent of all refueling stations, according to GSA. To help agencies locate alternative fuel stations, such as those with E85, DOE developed an Alternative Fuel Station Locator tool that maps nearby refueling

⁶⁰GSA also told us that manufacturers are scaling back the flex-fuel offerings, a step that will decrease the availability of vehicles. GSA has already started to see a decrease in the vehicles available for purchase and lease by agencies.

stations. VA and Interior officials said they routinely use the tool to check for accessible alternative fuel stations prior to acquiring an alternative fuel vehicle.⁶¹ However, outside the rural Midwest and Texas, E85 may be difficult to find. In addition, when E85 is available, agency officials from two case study agencies said these locations may be mislabeled, out of service, or too far from the vehicle's operating location. We reported similar concerns in 2011; specifically, that while agencies acquired primarily flex-fuel vehicles, the low availability of E85 resulted in a majority of flex-fuel vehicles receiving a waiver from the requirement to use alternative fuel, and as a result, agencies refueled their flex-fuel vehicles with petroleum.

Another difficulty fleet managers face with regard to increasing the use of E85 is that, even when E85 is available and conveniently accessible, drivers still may refuel with gasoline—even though federal agencies have undertaken a number of efforts to encourage its use. As we mentioned previously, to help agencies track their fleet fuel purchases, DOE developed the FLEETDASH system that can identify opportunities where drivers could have refueled with E85 within 5 miles of their location but, instead, chose not to because they were unaware or unwilling.⁶² Some agency officials described using this system to try to increase alternative fuel use. For example, VA officials told us they use FLEETDASH to track and identify opportunities to increase their alternative fuel use. In another example, EPA officials told us that to increase their use of alternative fuels, drivers at one location started to print out maps that identified alternative fuel refueling locations near their routes. DOE recently estimated that if federal agencies refueled flex-fuel vehicles with E85 every time they refueled within 5 miles of an E85 station, the use of E85 would quadruple, and agencies could decrease their use of petroleum by 10 percent and reduce greenhouse gas emissions by a further 9 percent.

⁶¹Under DOE guidance, agencies can be granted waivers from using alternative fuel in their dual-fueled vehicles based on the lack of an accessible alternative fuel refueling station within 5 miles and 15 minutes driving from its garage location.

⁶²As of January 2018, 29 agencies used FleetDASH, including Army, EPA, DOT, Interior, and VA.

Agencies' Need for Larger Vehicles Limits the Number of Low Greenhouse-Gas-Emitting Vehicles They Can Acquire

Another challenge that may limit further progress towards energy goals is that agencies continue to need larger, less efficient vehicles for many of their mission needs, according to many agency officials. According to FAST data, about 85 percent of agencies' fleets in fiscal year 2018 was comprised of sport-utility vehicles, passenger vans, and trucks (as illustrated previously in fig. 3). In response to our survey, 26 of 29 agencies indicated that mission or intended use was a very important factor when selecting a vehicle, and officials at some case study agencies told us that they had a significant need for larger vehicles to meet certain missions. For example, Interior operates on large rural Indian reservations where they need pick-up trucks or sport-utility vehicles to navigate the often rugged terrain. In another example, DOT officials stated that to support their national airspace facilities, their vehicles must drive off-road carrying bulky or sensitive tools to go to remote air strips. For these purposes, they look to acquire larger vehicles such as cargo vans and enclosed pickup trucks with 4-wheel drive capabilities or 2-wheel-drive sport-utility vehicles that have the ground clearance to meet their needs.

GSA and agency officials told us that the vehicles designated as low greenhouse-gas-emitting vehicles are typically smaller vehicles and in some cases are not suitable for these mission needs. For example, GSA offered one 4x2 hybrid-electric sport-utility vehicle and one 4x4 plug-in hybrid-electric sport-utility vehicle in fiscal years 2017 and 2018. In fiscal year 2019, additional vehicles have been added. While these options are considered low greenhouse-gas-emitting vehicles, an agency official told us that they have a variety of other characteristics that may make them less desirable for certain missions—for example, they may cost significantly more than other options to acquire, or, in the case of the plug-in, rely on charging infrastructure that the agency may not have in the location where the vehicle is needed. According to VA staff, there are not enough low greenhouse gas vehicle options to ensure fleet managers can meet mission goals and low greenhouse-gas-emitting vehicle acquisition requirements. For example, VA relies on minivans to transport patients and deliver health care services; however, no gasoline or E85-fueled minivans offered by GSA in fiscal year 2017 were designated as low greenhouse-gas-emitting vehicles. Furthermore, in some cases, when an agency has determined it needs a larger vehicle, fleet managers told

us they are likely to choose a flex-fuel vehicle because these vehicles are offered in larger, more rugged models. These vehicles are often not designated as low greenhouse-gas-emitting vehicles but count towards the alternative fuel vehicle acquisition requirements.

In contrast, officials representing four case study agencies stated that when the mission need is suitable for a sedan, the agency seeks to acquire low greenhouse-gas-emitting vehicles. GSA offers a number of alternative fuel vehicle options for sedans, including hybrid, battery electric, and plug-in electric hybrid vehicles. Further, many GSA offered gasoline-fueled sedans are also designated as low greenhouse-gas-emitting vehicles. Officials at one agency told us, when possible, the agency acquires alternative fuel sedans such as flex-fuel vehicles, hybrid vehicles, or, in a few cases, electric vehicles. Furthermore, officials at this agency stated that when they are acquiring a vehicle where alternative fuel is not readily available, they will sometimes acquire a low greenhouse-gas-emitting vehicle that runs only on gasoline.

Agency Comments

We provided a draft of this report to Army, DOE, DOT, EPA, GSA, Interior, and the VA for their review and comment. In response, Army, DOE, EPA, GSA, Interior, and VA provided technical comments which were incorporated as appropriate. Army and DOT reviewed the report but did not provide any comments.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to the Secretaries of the Departments of Defense, Energy, Interior, and Veterans Affairs, and the Administrators of GSA and EPA. In addition, the report will be available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff has any questions about this report, please contact me at 202-512-2834 or vonaha@gao.gov. Contact points for our Office of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff that made major contributions to this report are listed in appendix IV.

A handwritten signature in black ink, appearing to read 'Andrew Von Ah'. The signature is fluid and cursive, with a large initial 'A' and 'V'.

Andrew Von Ah
Director, Physical Infrastructure

Appendix I: Survey of Federal Agencies on Acquiring Alternative Fuel Vehicles

In April 2018, we initiated a survey of 29 federal agencies’ fleet managers. The questions we asked and the aggregate results of the responses to the closed-ended questions are shown below. Our survey was comprised of closed- and open-ended questions. We do not provide results for the open-ended questions. We received 29 completed survey responses—a response rate of 100 percent.¹

1. What is the process your agency follows when acquiring a new vehicle to replace a vehicle?

Please list (in numerical order) the sequence of events from deciding to acquire a vehicle to actually acquiring it. To the extent that the process is different when adding an additional vehicle, please describe that as well.

(Written responses not included)

2. At what point in the above process, does your agency consider whether to acquire an alternative fuel vehicle or a petroleum fuel vehicle when replacing a vehicle? To the extent that the process is different when adding an additional a vehicle, please describe that as well.
3. (Written responses not included)In the process to replace a vehicle described above, does your agency consider vehicle life-cycle cost information as part of a lease versus purchase analysis?²

Response	Number of responses
Yes	18

¹For our purposes, we studied 29 agencies that were subject to the fleet energy requirements. We excluded two agencies subject to the requirements because of one agency’s decentralized fleet and the other’s small fleet size.

²We did not define “life-cycle cost” as part of the survey, thus this was left up to the interpretation of the respondents.

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Response	Number of responses			
No	11			
No answer/not checked	0			
3a. If yes, does your agency consider the following factors in their vehicle life-cycle cost analysis? Please check one answer for each row.				
Response	Yes	No	Don't know	No answer/not checked
Fuel cost	17	1	0	0
Initial capital cost	17	1	0	0
Maintenance costs	17	1	0	0
Useful life (number of years it is expected to be used)	17	1	0	0
Annual miles	16	2	0	0
Fuel or electricity consumption	16	1	1	0
Climate	14	3	1	0
Terrain	14	2	1	0
Depreciation	13	5	0	0
Salvage/resale value	12	6	0	0
Driving patterns	11	6	1	0
Accident repair costs	10	6	1	0
Disposal costs	10	8	0	0
Discounting	9	6	2	1
Equipment operator cost	9	8	1	0
(In the case of an electric vehicle) Source of electricity generated (i.e. coal, wind, etc.)	6	11	1	0
Storage cost	6	11	1	0
Other ^a	5	3	2	8
Taxes	2	13	3	0

Note: One agency responded "No" to Question 3 and also responded to a sub-question that should have been skipped. We omitted the agency response to the sub-question from our analysis.

^aFor agencies that indicated there were other factor(s), we provided an open-ended question that requested a description of the factor(s) and six agencies provided descriptions of other factors not shown here, including one that had not responded to the "Other" sub-question and one that had responded "No" to Question 3.

4. In the process to add an additional vehicle, does your agency consider vehicle life-cycle cost information as part of a lease versus purchase analysis?

Response	Number of responses
Yes	20
No	9
No answer/not checked	0

4a. If yes, please describe how, if at all, the above lease versus purchase analysis differs in the case of adding an additional vehicle, and in particular any differences in the type of life-cycle cost information considered in the case of adding a vehicle.

(Written responses not included)

5. Excluding the lease versus purchase analysis, does your agency conduct any other vehicle life-cycle cost analysis at any other point in the vehicle replacement process described in Question 1?

Response	Number of responses
Yes	14
No	15
No answer/not checked	0

5a. Does your agency compare the life-cycle costs of multiple vehicle types prior to selecting a type of vehicle to acquire?

Response	Number of responses
Yes	13
No	1
No answer/not checked	0

Note: Three agencies responded "No" to Question 5 and also responded to this sub-question that should have been skipped. We omitted the responses to this sub-question from our analysis.

5b. Does your agency perform a cost analysis comparing life-cycle costs of acquiring a non-electric vehicle to costs of acquiring an electric vehicle?

Response	Number of responses
Yes	13
No	1

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No answer/not checked 0

Note: Five agencies responded “No” to Question 5 and also responded to this sub-question that should have been skipped. We omitted the responses to this sub-question from our analysis.

5c. If no, please describe how your agency considers the results of this life-cycle cost analysis—excluding the lease versus purchase analysis.

(Written responses not included)

5d. What factors below does your agency consider in this life-cycle cost analysis? Please check one answer for each row.

Response	Yes	No	Don’t know	No answer/not checked
Initial capital cost	14	0	0	0
Fuel cost	13	0	1	0
Fuel or electricity consumption	13	0	1	0
Useful life (number of years it is expected to be used)	13	0	1	0
Annual miles	12	1	1	0
Maintenance costs	11	2	1	0
Terrain	11	2	1	0
Climate	10	3	1	0
Driving patterns	10	3	1	0
Depreciation	8	4	1	1
Disposal costs	7	5	1	1
Salvage/resale value	7	5	1	1
Accident repair costs	6	6	1	1
Equipment operator cost	6	5	2	1
Storage cost	6	6	1	1
(In the case of an electric vehicle) Source of electricity generated (i.e. coal, wind, etc.)	5	7	1	1
Other ^a	5	2	0	8
Discounting	4	5	3	2
Taxes	1	10	2	1

Note: Three agencies responded “No” to Question 5 and also responded to sub-questions that should have been skipped. We omitted the responses to sub-questions from our analysis.

^aFor agencies that indicated there were other factor(s), we provided an open-ended question that requested a description of the factor(s) and 5 agencies provided descriptions of other factors not shown here.

6. In the process to add an additional vehicle, does your agency consider vehicle life-cycle cost information at any point outside the lease versus purchase analysis?

Response	Number of responses
Yes	7
No	22
No answer/not checked	0

6a. If yes, please describe how, if at all, any life-cycle cost analysis described in question 5 differs in the case of adding an additional vehicle, and in particular any differences in the type of life-cycle cost information considered in the case of adding a vehicle.

(Written responses not included)

7. Has your agency ever determined that an electric vehicle is the most appropriate vehicle to meet the agency's needs?

Response	Number of responses
Yes	23
No	6
No answer/not checked	0

7a. If yes, please provide some examples of those situations and how your agency determined the type of electric vehicle (i.e. electric vehicle, plug-in electric hybrid vehicle, hybrid electric, etc.).

(Written responses not included)

8. How important are the following factors when determining whether the vehicles your agency acquires will be alternative fuel vehicles or petroleum fuel vehicles?

Response	Very Important	Somewhat Important	Considered but not important	Not Considered	No answer/not checked
Mission (The expected function or purpose of the vehicle)	26	0	2	1	0
Availability of alternative fuels	25	2	0	1	0
Availability of alternative fuel vehicles	23	4	1	1	0

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Federal requirements	23	5	1	0	0
Vehicle range	22	5	1	1	0
Cost effectiveness	21	5	1	2	0
Costs	20	5	2	1	0
Terrain	15	7	5	2	0
Weather	10	8	5	6	0
Other (specify in box below) ^a	2	0	0	3	24

Note: In two instances, an agency marked more than one response for a sub-question, so we omitted these responses from our analysis.

^aFor agencies that indicated there were other factor(s), we provided an open-ended question that requested a description of the factor(s) and 3 agencies provided descriptions of other factors not shown here.

9. What are the benefits, if any, (including any related to costs, maintenance, environment, safety, federal requirements, etc.) of acquiring and using each of the following types of alternative fuel vehicles relative to petroleum fuel vehicles?

9a. Electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs) that use battery power

(Written responses not included)

9b. Hybrid electric vehicles (HEVs) powered by an internal combustion engine

(Written responses not included)

9c. Flex Fuel Vehicles (FFVs) designed to run on E85

(Written responses not included)

9d. Other alternative fuel vehicles

(Written responses not included)

10. What are the challenges, if any, (including any related to costs, maintenance, environment, safety, federal requirements, etc.) of acquiring and using each of the following types of alternative fuel vehicles relative to petroleum fuel vehicles?

10a. Electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs) that use battery power

(Written responses not included)

10b. Hybrid electric vehicles (HEVs) powered by an internal combustion engine

(Written responses not included)

10c. Flex Fuel Vehicles (FFVs) designed to run on E85

(Written responses not included)

10d. Other alternative fuel vehicles

(Written responses not included)

11. How many electric charging stations has your agency installed?

Response	None	1-5	6-10	11-20	21 or more	No answer/not checked
Number of responses	3	5	6	3	12	0

12. Has your agency encountered any challenges while trying to site and install electric charging stations?

Response	Number of responses
Yes	18
No	7
Not applicable	3
No answer/not checked	1

Note: One agency responded "No" and "NA" to Question 12. For the previous question, the agency responded that it had installed electric charging stations. Thus, we determined that the agency response to Question 12 was "No."

12a. If yes, what were those challenges and how, if at all, have you been able to overcome them?

(Written responses not included)

13. Has your agency encountered any challenges related to acquiring and using alternative fuel vehicles and alternative fuel while trying to meet federal fleet energy requirements, including Executive Order 13693?

Response	Number of responses
Yes	23
No	6
No answer/not checked	0

13a. If yes, what were those challenges and how, if at all, have you been able to overcome them?

(Written responses not included)

14. Has your agency taken steps to prepare for Executive Order 13693's requirement that 20 percent of all new passenger vehicles be zero emission vehicles or plug-in hybrids by 2020?

Response	Number of responses
Yes	25
No	4
No answer/not checked	0

14a. If yes, please provide some examples of the steps you have taken.

(Written responses not included).

15. Has the availability of alternative fuel vehicles from GSA's inventory ever prevented your agency from acquiring an alternative fuel vehicle?

Response	Number of responses
Yes	14
No	15
No answer/not checked	0

15a. If yes, please describe what vehicle you were interested in and why it was not available.

(Written responses not included)

Appendix II: Objectives, Scope, and Methodology

You asked us to review the costs and challenges related to federal agencies' meeting the different federal energy requirements for vehicle fleets. This report addresses: (1) how agencies meet fleet energy requirements and how their efforts changed agencies' fleets and (2) challenges federal agencies faced related to furthering fleet energy goals. The report also includes information on the extent agencies consider life-cycle costs when selecting vehicles.

To determine the extent to which federal agencies reported meeting fleet energy requirements and the composition of federal agencies' fleets, we analyzed data from the Federal Automotive Statistical Tool's (FAST) database on the composition and fuel use of federal agencies' fleets from fiscal years 2008 through 2017, the most current data available at the time of our review. Annually federal agencies must submit data on all of their non-tactical vehicles to this database, which the General Services Administration (GSA) and the Department of Energy (DOE) established in 2000 and is used to satisfy statutory and regulatory reporting requirements. We reviewed the data relative to selected statutory requirements and directives that were in effect for fiscal year 2017. Specifically, we analyzed these data to identify the total numbers of alternative fuel vehicles by fuel type and vehicle size in federal fleets and the changes in alternative fuel use during this time period. DOE provided us fleet performance data on the extent to which each of the agencies subject to these federal requirements met requirements or directives to acquire alternative fuel vehicles, use alternative fuel, and reduce petroleum use and per-mile greenhouse gas emissions for fiscal year 2017. In addition, the Environmental Protection Agency (EPA) reported on the extent to which agencies were meeting the requirement to acquire low greenhouse-gas-emitting vehicles for fiscal year 2017, based on the same database. To assess the reliability of these data, we interviewed DOE officials on how the data were checked for accuracy and collected written responses from them on how the data were collected, maintained, analyzed and presented. This assessment included how DOE flags suspicious data, reviews the data, and validates final entries. Based on the information collected, we found the data sufficiently reliable for our purposes of identifying the number of vehicles by type of vehicle and size,

and fuel consumed by federal fleets in order to describe how vehicle fleets changed over the past decade.

In May 2018, a new Executive Order was issued that revoked a previous Executive Order. The previous Executive Order contained two directives, to acquire zero emission (electric) vehicles and reduce per-mile greenhouse gas emissions by specific targets and specific years. Thus, while the above statutory requirements for fiscal year 2017 remained in effect for fiscal year 2018, the directives related to acquisition of zero emission (electric) vehicles and per-mile greenhouse gas emissions reductions were no longer in effect after May 2018. To understand the different federal energy requirements for vehicles fleets and guidance for agencies to implement them, we reviewed federal statutes, agency rules, and executive orders, and examined DOE and GSA guidance on the various statutory and regulatory requirements and executive orders. For example, we reviewed DOE's federal fleet management handbook intended for agencies to select and implement strategies to reduce fleet greenhouse gas emissions and use of petroleum, and EPA guidance on how to meet the requirement to acquire low greenhouse-gas-emitting vehicles, among other documents. In April 2019, CEQ and OMB issued implementing instructions for the Executive Order.¹ The implementing instructions emphasized that agencies should follow the statutory requirements that are still in place and annually identify targets for petroleum reduction and increases in alternative fuel use as part of agencies' Strategic Sustainability Plans.

To broaden our understanding of agencies efforts to meet requirements, we also identified five case study agencies—Department of the Interior (Interior), Department of Veterans Affairs (VA), Department of Transportation (DOT), the Army, and the EPA. We selected these case study agencies based on data from the FAST database and their planning documents to represent different sized fleets, a mix of alternative fuel vehicle types, including electric vehicles, and missions with varying vehicle needs. Interior, VA, and Army represented larger fleets, whereas DOT represented medium and EPA small sized fleets.² In part, we also

¹The Executive Order authorized CEQ to review and where needed, revise existing guidance.

²For our purposes, a large fleet operates 10,000 or more light-duty vehicles; a medium fleet operates between 3,000 to 10,000 light-duty vehicles; and a small fleet operates less than 3,000 light-duty vehicles. Light-duty vehicles were the focus of our fleet size criteria since they have the most alternative fuel vehicle options.

chose DOT and EPA to learn about their unique vehicle acquisition processes and plans for acquiring electric vehicles, based on their responses to the survey we conducted, which is described below. From these case study agencies and their sub-agencies, we interviewed agency officials, including fleet managers, to learn their efforts to meet requirements, how they acquired vehicles, and how they managed their fleets. We spoke with these agencies before and after the Executive Order was revoked in May 2018. We also reviewed documents reporting on the extent to which these agencies met fleet energy requirements. The results from the case studies cannot be generalized to make inferences about all agencies. However, we determined that our selection methodology was appropriate for our design and objectives and that this methodology would generate valid and reliable evidence to support our work.

To determine any challenges agencies face related to further meeting fleet energy goals, we surveyed 29 federal agencies, and asked them to describe their vehicle acquisition processes, the type of cost analysis done when acquiring an alternative fuel vehicle, and the benefits and challenges of using alternative fuel vehicles. We identified and surveyed agencies that were required to comply with fleet energy requirements and conducted the survey beginning in April 2018. Overall, 31 federal agencies were subject to these requirements in fiscal year 2017; however, as part of our review of Department of Defense (DOD) documentation, we found that its various military departments operate independently and decided to survey Air Force, Army, Marine Corps, and Navy separately. We also excluded the Court Services and Offender Supervision Agency because of the decentralized nature of its fleet and the Defense Agencies within DOD because it was small relative to other DOD agencies. To increase the validity and reliability of our survey, we conducted pretests of the survey with fleet management officials from three federal agencies: VA, Interior, and the Government Accountability Office. We received a 100 percent response rate to our survey. (See app. I for survey results.)

To further learn about the challenges of alternative fuel vehicles as well as strategies agencies were using to acquire these vehicles, we interviewed agency officials, including fleet managers, from our five case study agencies, GSA and DOE. In addition, to understand agencies' efforts to further fleet energy goals and the challenges they faced, we reviewed the Fleet Management Plans and Strategic Sustainability

Performance Plans of each agency we surveyed.³ The strategic sustainability plan is to prioritize agency actions to support the reduction of greenhouse gas emission and other agency wide targets. The fleet management plan is to specifically address how an agency's fleet will meet its greenhouse gas reduction targets, petroleum reduction targets, and other relevant fleet requirements. We also focused our analysis only on selected types of alternative fuel vehicles. Specifically, we included flex-fuel vehicles, hybrid-electric vehicles, plug-in hybrid electric vehicles, and battery electric vehicles because these represent the most numerous in federal fleets or those with specific acquisition requirements.⁴

We obtained vehicle cost information from GSA's Alternative Fuel Vehicle Guide that lists the costs and specifications of each alternative fuel vehicle GSA offers, and analyzed cost differences based on fuel type. For the purposes of our analysis, we focused on lease costs, not the costs of purchasing a vehicle from GSA, because in fiscal year 2017, 70 percent of agencies battery electric and plug-in hybrid electric vehicles were leased. To analyze and compare petroleum consumption and greenhouse gas emissions, we judgmentally selected a sample of vehicles from GSA's Alternative Fuel Vehicle Guide and first estimated their annual fuel using DOE's Vehicle Cost Calculator.⁵ We then entered their estimated fuel use into Argonne National Laboratory's Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) tool to estimate well to wheel greenhouse gas emissions.⁶ To assess the reliability of

³Section 14 of Executive Order 13693 requires that each agency develop and annually update a Strategic Sustainability Performance Plan that includes how the agency will achieve its greenhouse gas reduction targets, among other goals. Fleet Management Plans establish an agency's strategy for achieving its full compliance with current fleet management and sustainability mandates, among other purposes.

⁴In 2019, GSA offers other types of alternative fuel vehicles, including: bio-diesel capable vehicles, compressed natural gas vehicles, propane vehicles, liquefied natural gas vehicles, and low speed electric vehicles.

⁵DOE's Vehicle Cost Calculator can estimate annual fuel costs based on miles driven and the vehicle's city and highway fuel economy, among other variables. For the purposes of our analysis, we used the average miles driven for a federal sedan or sport-utility vehicle obtained from GSA's report on FAST data.

⁶DOE developed the AFLEET tool to enable users to estimate a vehicle's petroleum use, greenhouse gas emissions, air pollutant emissions, and cost of ownership based on the vehicle type, fuel type, and various assumptions such as miles driven. For our purposes, we assumed the vehicles were operating in the northeast or the upper Midwest of the United States—the regions with the least and highest percentage of power generated from coal, respectively.

these tools, we interviewed and collected written responses from DOE officials regarding the source of the data and the values and assumptions used in its calculations. Based on the information collected, we found that they were sufficiently reliable to estimate petroleum consumption and greenhouse gas emissions.

We conducted this performance audit from November 2017 to July 2019 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix III: Agencies' Consideration of Costs in Selecting Electric Vehicles

Until May 2018—during the time when the previous administration's Executive Order was in effect—our case study agencies acquired limited numbers of battery electric and plug-in hybrid electric vehicles with a general understanding that, when the mission need was compatible, acquiring such vehicles was supported by the Executive Order's requirements in spite of their higher costs compared to a conventional vehicle. As of February 2019, the last time we spoke with agency officials on this issue, agency officials stated that they were uncertain of the effect of the new executive order and would continue to try and meet fleet energy goals until new guidance was issued. This guidance was subsequently issued in April 2019, and emphasized that agencies should focus on the statutory requirements while increasing efficiency, optimizing performance, and reducing waste and costs.

- Until May 2018, when the previous Executive Order was revoked, agencies were expected to increase their acquisition of battery electric or plug-in hybrid electric vehicles. Specifically, agencies were to acquire “zero-emission” or plug-in hybrid electric vehicles for 20 percent of all new agency passenger vehicle acquisitions by December 31, 2020—and for 50 percent of all new agency passenger vehicle acquisitions by December 31, 2025—in addition to meeting the other various federal fleet requirements. According to Department of Energy guidance on this Executive Order, the targets phased in over time to account for the expected future market availability and cost competitiveness of these vehicles. However, as of fiscal year 2017, GSA officials and several fleet managers also told us that in their experiences leasing electric vehicles, the lower mileage costs of these vehicles had not made up for the significantly higher acquisition cost over the life of the leases, a situation that they described as a challenge to significantly increasing the numbers of such vehicles in their fleets. Three case study agencies described acquiring battery electric and plug-in hybrid electric vehicles—despite the higher costs—largely because of the Executive Order's requirement. Similarly, 10 of the 29 agencies we surveyed identified “meeting federal requirements” as a key benefit to acquiring electric vehicles.

- All five case study agencies had acquired small numbers of electric vehicles in light of the Executive Order's requirements. Agency officials described acquiring these vehicles when their mission and budgets allowed for it. For example, a case study agency with a larger fleet told us that mission needs drove its vehicle acquisitions, and there were limited instances in which an electric sedan would have met the agency's mission needs. However, when the agency acquired a vehicle for a mission that could be met with an electric vehicle—such as to ferry officials to and from different offices in an area where charging stations were easily accessible—it would have been likely to select an electric vehicle, in part, to help the agency take steps towards meeting the Executive Order's acquisition goals.
- Agency officials at four of the five case study agencies said once they had identified an opportunity to acquire an electric vehicle—generally at a location where the mission aligned with the capabilities of an electric vehicle, recharging infrastructure was available, and there were sufficient funds in the budget—they would conduct a lease versus purchase analysis to determine whether leasing or purchasing the vehicle would be most the cost effective option, a key aspect of a life-cycle cost analysis. We have previously reported that a life-cycle cost analysis, which considers vehicle costs from the beginning to the end of vehicle ownership, can help agencies make cost-effective decisions.¹ Officials at the fifth case study agency, Army, stated that the agency had conducted an agency-wide analysis that had determined that leasing was always a better option than purchasing for non-tactical vehicles, and so it no longer conducted this analysis on a vehicle-by-vehicle basis.

Officials at our case study agencies stated they did not conduct life-cycle cost analysis to compare and contrast different types of vehicles during the acquisitions process because they considered mission and federal fleet energy requirements to be the key drivers of which type of vehicle to select. However, about half of the agencies that responded to our survey stated that they did do so. Specifically, 14 of 29 agencies indicated they conduct a life-cycle costs analysis outside of a lease-versus-buy analysis when replacing a vehicle, and 13 of these agencies responded that they did such an analysis to compare the costs of an electric vehicle to a non-electric vehicle. Almost all of these agencies responded that they considered initial acquisition cost,

¹GAO, *Federal Vehicle Fleets: Adopting Leading Practices Could Improve Management*, [GAO-13-659](#) (Washington, D.C.: July 31, 2013.)

fuel cost, electricity consumption, useful life, maintenance costs, and annual miles, with fewer agencies checking that they considered other costs, such as depreciation and disposal costs.

As of February 2019, the last time we spoke with agency officials on this issue, agency officials stated that they were unsure of how the revoking of the previous Executive Order and implementation of the new Executive Order would affect the extent to which they acquired electric vehicles in the future. Officials at one case agency stated that with the uncertainty surrounding the requirement to acquire more of these vehicles in the future, it was likely that they would not acquire electric vehicles due to their higher costs. Another case study agency said that although the Executive Order had been revoked, the agency may continue to acquire a limited number of these vehicles in locations where it had already invested funds for electric vehicle infrastructure.

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

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Staff Acknowledgments

In addition to the individual named above, Alwynne Wilbur (Assistant Director); Eric Hudson (Analyst-in-Charge); Ross Gauthier; Bonnie Ho; Malika Rice; Amy Rosewarne; Kelly Rubin; Andrew Stavisky; and Crystal Wesco made key contributions to this report.

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