SWT-2016-12 OCTOBER 2016

A Survey of Fuel Economy and Fuel Usage by Heavy-Duty Truck Fleets

Brandon Schoettle
Michael Sivak
Michael Tunnell

SUSTAINABLE WORLDWIDE TRANSPORTATION
UNIVERSITY OF MICHIGAN

A SURVEY OF FUEL ECONOMY AND FUEL USAGE BY HEAVY-DUTY TRUCK FLEETS

Brandon Schoettle [1]
Michael Sivak [1]
Michael Tunnell [2]

[1] The University of Michigan
Sustainable World Transportation
Ann Arbor, Michigan 48109-2150
U.S.A.

[2] American Transportation Research Institute
Arlington, Virginia 22203
U.S.A.

Report No. SWT-2016-12
October 2016

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
SWT-2016-12		

4. Title and Subtitle	5. Report Date
A Survey of Fuel Economy and Fuel Usage by Heavy-Duty Truck Fleets	October 2016
	6. Performing Organization Code: 322501

7. Author(s)	8. Performing Organization Report No.
Brandon Schoettle, Michael Sivak, and Michael Tunnell	SWT-2016-12

9. Performing Organization Name and Address	10. Work Unit no. (TRAIS)
The University of Michigan Sustainable Worldwide Transportation 2901 Baxter Road Ann Arbor, MI 48109-2150 U.S.A.	11. Contract or Grant No.

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
ExxonMobil Corporation Irving, TX 75039	14. Sponsoring Agency Code

15. Supplementary Notes

This study was performed in collaboration with the American Transportation Research Institute (ATRI), 950 N. Glebe Rd., Arlington, VA 22203.

16. Abstract

This report focuses on heavy-duty fleet fuel economy and related fuel-saving technologies and policies. The main objective of this survey was to understand the current on-road fuel economy performance of heavy-duty truck fleets, and the effects of fuel-saving technologies, strategies, and regulations on such fleets. Also of interest in this survey were various fuel-saving methods fleet managers have employed that have been beneficial, as well as those that have not. Fleet managers were asked to provide overall fleet characteristics and fuel economy information, including their views regarding current and future technologies, strategies, alternative fuels, and regulations. The survey yielded completed responses from 96 heavy-duty fleet managers, operating a combined total of just over 114,500 truck-tractors and approximately 350,000 trailers, and hauling a total of 9 billion tons of freight across 1.8 billion miles annually.

The main findings are as follows:

- The median heavy-duty fleet fuel economy reported in this study was 6.5 mpg, with the typical fleet hauling 2.1 million tons of cargo 10 million miles annually.
- Every heavy-duty fleet included in this survey currently uses diesel fuel, with biodiesel blends (B5, B10, and B20) being the most common alternative fuels in use.
- Fleet managers generally see the top advantages of specific alternative fuels as: lower in cost, cleaner (reduced emissions), and more available than other alternative fuels; they see the disadvantages of specific alternative fuels as: having low (or no) availability or infrastructure for distribution, increased cost overall, and possibly lowering fuel economy for their fleet.
- The most common fuel-saving technologies on the truck-tractor were: aluminum wheels, speed limiters, and low-rolling resistance dual tires; the most common fuel-saving technologies on trailers were: low-rolling resistance dual tires, aluminum wheels, and weight-saving technologies.
- The smallest fleets require faster payback periods than medium and large fleets when investing in fuel-saving technologies or when considering switching their heavy-duty fleet to an alternative fuel.
- Nearly all fleet managers feel that EPA heavy-duty emissions regulations will lead to higher or significantly higher truck operating costs, and all fleet managers surveyed feel that such regulations will lead to higher or significantly higher new truck purchase costs.

17. Key Words	18. Distribution Statement
Heavy duty, tractor, trailer, class 7, class 8, truck fleet, fuel economy, fuel usage, fuel-saving technologies, truck emissions, regulations	Unlimited

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
None	None	56	

Contents

Acknowledgments iii
Introduction 1
Overview of the U.S. Trucking Industry 2
Method 4
Survey instrument 4
Respondents 4
Results 6
Heavy-duty fleet fuel economy 6
Cargo carrying 7
Route types 8
Fuel costs 9
Idling and low-speed travel 10
Truck-based fuel-saving technologies and strategies 12
Speed limiters and over-speed alerts 18
Trailer ownership 19
Trailer-based fuel-saving technologies and strategies 20
Payback period for fuel-saving technologies 23
Diesel fuel price requiring new fuel-saving technologies 24
Best return on investment with fuel-saving technologies 25
Worst return on investment with fuel-saving technologies 27
Technology or policy fleet managers would like to see no longer required 29
Impact of EPA regulations on truck operating and purchasing costs 31
Fuel type usage 33
Advantages of fuel types being considering for use 36
Disadvantages of fuel types considering for use 37
Private fueling facilities 38
Payback period for switching heavy-duty fleet to an alternative fuel 39
Key Findings 40
Summary 43
References 44
Appendix: Questionnaire 46

Acknowledgments

This research was made possible by an unrestricted gift from ExxonMobil Corporation to the University of Michigan Transportation Research Institute (UMTRI).

The authors would like to thank John Woodrooffe for his guidance in helping develop the survey instrument used for this study. Daniel Murray, Vice President, Research at the American Transportation Research Institute (ATRI) provided invaluable assistance in the development of the survey instrument and in contacting and recruiting heavy-duty trucking fleet managers to complete this survey.

Study co-author Michael Tunnell is the Director of Environmental Research at ATRI.

Introduction

In recent years, there has been an increased focus on reducing greenhouse gas (GHG) emissions and fuel consumption in the transportation sector, not only from light-duty vehicles (i.e., passenger cars and light trucks), but also from medium- and heavy-duty trucks. This increased focus has mostly come in the form of newly issued regulations that seek to significantly reduce both consumption and the emissions that result from the burning (or production) of transportation fuels (EPA/NHTSA, 2012, 2016a). A report published earlier this year (Sivak and Schoettle, 2016) documented how most sectors of the U.S. economy, and even most sources of transportation emissions, have shown little relative change in GHG emissions in recent years. However, relative emissions from medium- and heavy-duty trucks have increased over the period examined (1990 through 2014). These recent increases in emissions, coupled with reductions from the latest EPA/NHTSA GHG regulations, only serve to increase the importance of understanding and improving upon current heavy-duty truck fuel economy.

In fact, reducing transportation-related emissions will likely gain even more importance in the coming years, as the push for greater GHG reductions comes not only from regulators within the U.S., but also on an international level (United Nations, 2015). As GHG reductions occur in other sectors of the economy, transportation-related emissions will naturally constitute a larger percentage of overall emissions. It is expected that such emissions will receive additional scrutiny in the future unless the transportation sector is able to keep pace with reductions from other sources of GHGs (Sivak and Schoettle, 2016).

The primary source of the emissions being discussed—fuel (usually diesel)—consistently represents one of the largest costs for trucking companies (ATRI, 2016). In conjunction with the pressure from the newly enacted fuel economy and emissions standards, these factors have increased the focus on fuel economy in the trucking industry and are leading to the deployment of new technologies and practices to reduce fuel consumption. Consequently, a project was developed to investigate current views regarding fuel-related technologies and practices among fleet managers in the heavy-duty trucking industry. To accomplish this goal, a new survey was developed for this study to better understand fleet

managers' views about fuel usage, fuel economy, and fuel-saving technologies being used or considered for use in heavy-duty* trucking fleets in the U.S.

Overview of the U.S. Trucking Industry†

Trucking is often viewed as a barometer of the U.S. economy. In 2015, the trucking industry hauled 70 percent of all freight transported in the United States, equating to more than 10 billion tons. Trucking also collected 81.5 cents of every dollar spent on freight transportation in 2015, representing more than $726 billion in gross revenue. Over the next decade, trucking volumes are expected to increase by 17 percent, while revenues are projected to increase nearly 50 percent (ATA, 2015).

More than 80 perent of U.S. communities rely exclusively on trucks to deliver their goods and commodities—providing modern conveniences to the nation's most remote populations. Using ATRI's truck global positioning system (GPS) dataset, truck activity is found nearly everywhere in the continental U.S. on a given day (see Figure 1).

Approximately 1.5 million interstate motor carriers are on file with the Federal Motor Carrier Safety Administration, almost equally divided between for-hire carriers and private carriers. For-hire carriers offer freight transportation services to the public, while private carriers operate a fleet of trucks that supports their primary business. While more than 30 for-hire motor carriers had annual revenues of more than $1 billion in 2015, the industry is largely comprised of small carriers. Nearly 97 percent of motor carriers operate 20 or fewer trucks, while 91 percent operate 6 or fewer trucks.

Of the estimated 31 million trucks registered for commercial use in 2014, 2.6 million were truck-tractors. Truck-tractors are the most common type of large freight truck and generally haul one or more trailers. These types of vehicle configurations are also known as "combination vehicles" or "tractor-trailers."

* For the purposes of this study, "heavy-duty" was defined as FHWA vehicle classes 7 and 8 (which correspond to EPA vehicle classes 7, 8a, and 8b); these classes include all vehicles with a GVWR ≥ 26,001 lbs. (AFDC, 2012b). For examples of vehicle types in each weight class, see AFDC (2012a).

† Unless otherwise noted, statistics in this section are from: *American Trucking Trends 2016* (ATA, 2016).

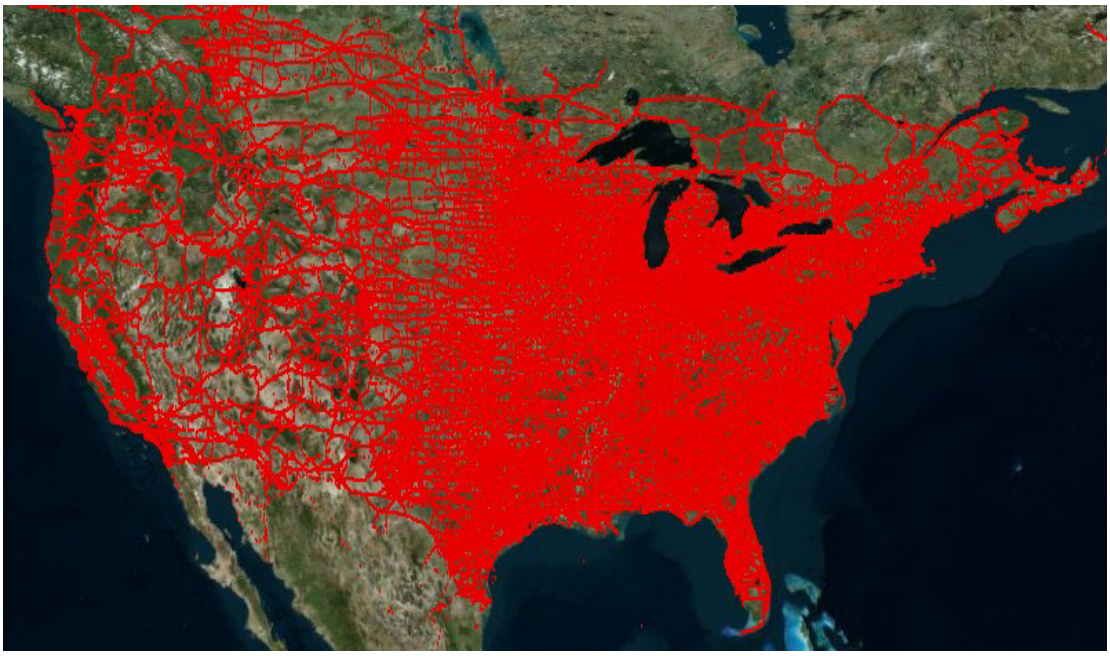

Figure 1. Truck travel (shown in red) in the United States over a single day.

In 2015, 54 billion gallons of fuel were consumed by trucks for business purposes—39 billion gallons of diesel fuel and 16 billion gallons of gasoline. Combination vehicles, which are powered nearly exclusively by diesel fuel, accounted for 75 percent of this diesel fuel consumption.

Large fleets typically sell (or otherwise replace) truck-tractors after the first three to five years of ownership and operation; however, smaller fleets and owner-operators continue to use these trucks for many years thereafter. The most common types of trailers in use today are dry vans and refrigerated vans. Together, these vans make up greater than 70 percent of all trailers (EPA/NHTSA, 2016b). Trailers that are purchased by fleets are typically kept much longer than tractors, so trucks and trailers have different purchasing cycles. Tractors tend to be replaced every 7 years on average, while trailers tend to be replaced every 12 years (ATRI, 2016).

Method

Survey instrument

An online survey was conducted using SurveyMonkey (www.surveymonkey.com), a web-based survey company. A questionnaire was developed to examine a variety of issues related to heavy-duty fleet fuel economy and fuel consumption, including operational strategies as well as implementation of technical solutions and the overall performance of such solutions. The full text of the questionnaire is included in the appendix. The survey was performed from early June 2016 through mid-August 2016.

Respondents

Heavy-duty fleet managers (or similarly knowledgeable fleet administrators) were contacted and recruited to complete the survey through a number of ATRI resources. A press release was issued by ATRI and circulated through the organization's e-mail distribution list. This release was reissued by a number of other organizations including the American Trucking Associations (ATA), ATA's Technology and Maintenance Council (TMC), National Private Truck Council (NPTC), and a number of state trucking associations. Print and radio news outlets focusing on trucking-related issues also provided coverage. Fully completed surveys were received from 96 individual heavy-duty fleet managers regarding their respective fleets. Demographic breakdowns for the included fleets are presented in Tables 1-A and 1-B.

The 96 fleets surveyed for this study operate a combined total of just over 114,500 truck-tractors and approximately 350,000 trailers, hauling a total of 9 billion tons of freight across 1.8 billion miles annually.

Table 1-A
Demographic breakdowns for the 96 heavy-duty fleets.

Demographic aspect		N	Percent
Fleet type (Q1)	For-hire	72	75.0
	Private	24	25.0
Fleet size (Q2) (total class 7 and 8 truck-tractors)	1-20	21	21.9
	21-100	22	22.9
	101-500	25	26.0
	501 or more	28	29.2

Table 1-B
Demographic breakdowns for the 96 heavy-duty fleets.

Demographic aspect		Min	Median	Max
Trailers owned or leased (Q13)	28'/33' trailers	1	40	34,000
	45' trailers	2	100	2,000
	48' trailers	1	52	5,000
	53' trailers	1	230	34,150
	Other trailer types	2	67	82,000
Total annual cargo (tons) [‡] (Q6)		50,000	2,142,965	500,000,000
Total annual distance driven (miles) (Q7)		90,000	10,000,000	1,150,000,000

[‡] U.S. ton (2,000 lbs.; "short ton").

Results

Heavy-duty fleet fuel economy

The median (50th percentile) heavy-duty fleet fuel economy for all fleets was 6.5 mpg.[§] Figure 2 and Table 2 present summaries of fuel economy by fleet size. Fuel economy generally increased as fleet size increased, with a difference of 0.5 mpg in median values across all fleet sizes.

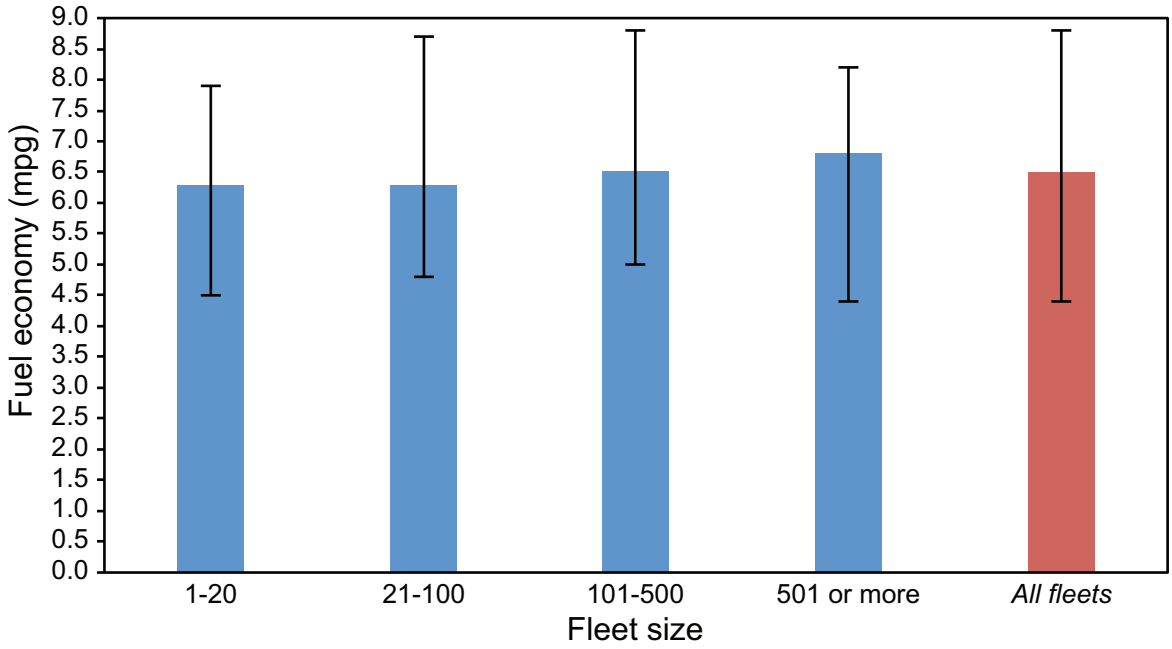

Figure 2. Heavy-duty fleet fuel economy (Q5), by fleet size. The errors bars show the range between minimum and maximum values.

Table 2
Heavy-duty fleet fuel economy (Q5), by fleet size.

Fleet size	*Miles per gallon (mpg)*		
	Min	Median	Max
1-20	4.5	6.3	7.9
21-100	4.8	6.3	8.7
101-500	5.0	6.5	8.8
501 or more	4.4	6.8	8.2
All fleets	***4.4***	***6.5***	***8.8***

[§] Fuel-economy values are 'real-world' or 'on-road' values as reported during the survey by fleet managers (either approximated or IFTA-based values [http://www.iftach.org/]) and not directly measured.

Cargo carrying

Figure 3 and Table 3 present summaries of cargo-carrying modes by fleet size. The values represent the mean percentage of cargo carried within each cargo-carrying mode. For all fleets, "weighing out" (filled to the maximum allowed weight) was the most common cargo carrying mode. Smaller fleets were the most likely to report hauling full loads (i.e., "weighs out", "cubes out", or "both"), while larger fleets were more likely than smaller fleets to report hauling less than full loads (i.e., "neither").

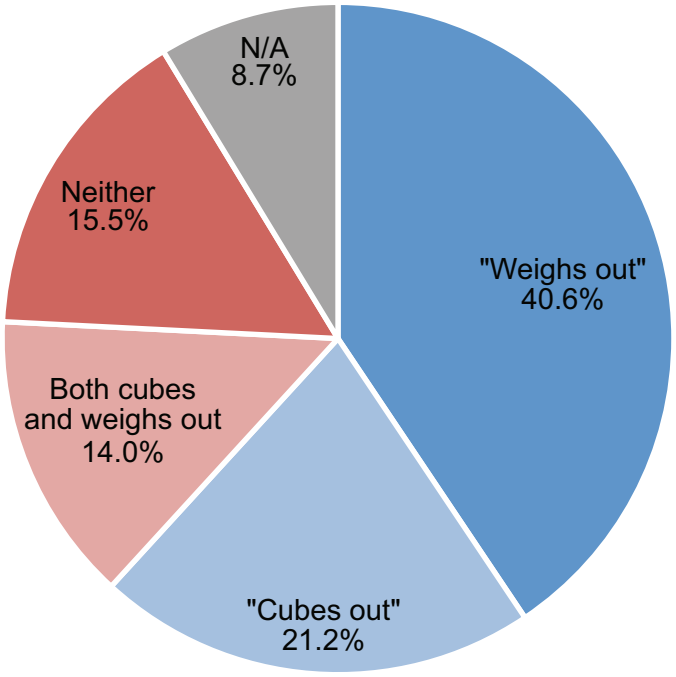

Figure 3. Cargo carrying modes (Q3), for all fleets.

Table 3
Cargo carrying modes (Q3), by fleet size.

Fleet size	*Percent*				
	"Weighs out" (max. weight)	"Cubes out" (max. volume)	Both cubes and weighs out	Neither	Not applicable (specialized trailers)
1-20	43.2	29.4	9.7	8.1	9.5
21-100	39.4	18.8	21.4	11.7	8.7
101-500	43.2	16.4	13.2	14.3	12.8
501 or more	37.1	21.1	12.2	25.2	4.4
All fleets	***40.6***	***21.2***	***14.0***	***15.5***	***8.7***

Route types

Figure 4 and Table 4 present summaries of route types by fleet size. The values represent the percentage of all routes operated within each route type. For all fleets, local/regional with same day return was the most common route type, except that the smallest fleets were most likely to report operating long-haul routes with an overnight stay. Furthermore, the smallest fleets were the least likely to report using team drivers for long-haul routes.

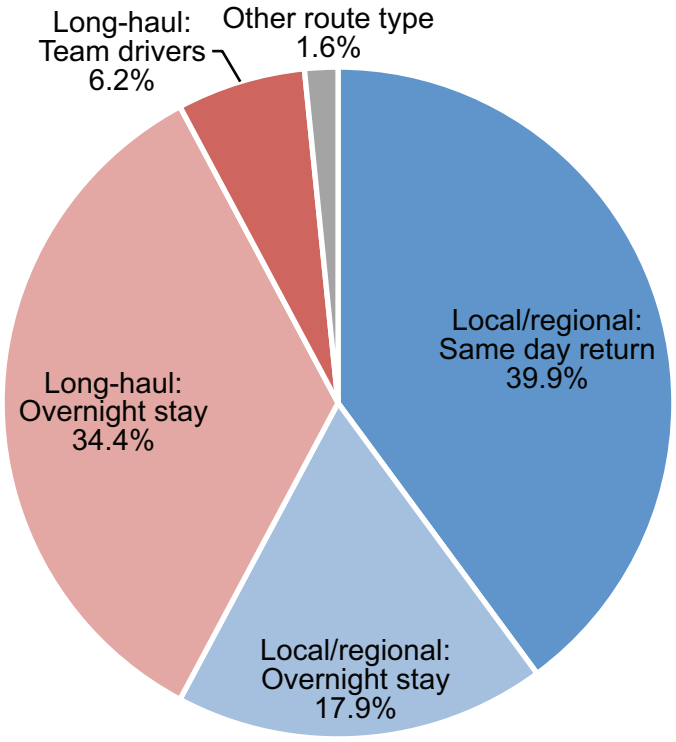

Figure 4. Route types (Q4), for all fleets.

Table 4
Route types (Q4), by fleet size.

Fleet size	*Percent*				
	Local/regional: Same day return	Local/regional: Overnight stay	Long-haul: Overnight stay	Long-haul: Team drivers	Other route type
1-20	37.1	15.6	47.2	0.0	0.0
21-100	38.8	27.9	23.3	8.9	1.1
101-500	39.3	13.4	34.9	7.4	5.0
501 or more	43.2	15.9	33.0	7.8	0.0
All fleets	***39.9***	***17.9***	***34.4***	***6.2***	***1.6***

Fuel costs

Table 5 presents a summary of fuel costs as a percentage of total operating costs by fleet size. Fuel costs, as a percentage of operating costs, decreased as fleet size increased. The median percentage of total operating costs spent on fuel for all fleets was 24 percent.

Table 5
Fuel costs as a percentage of total operating costs (Q8), by fleet size.

Fleet size	*Fuel costs (percent)*		
	Min	Median	Max
1-20	17.0	30.0	55.0
21-100	8.0	25.0	45.0
101-500	10.0	19.5	45.0
501 or more	5.0	16.0	60.0
All fleets	***5.0***	***24.0***	***60.0***

Idling and low-speed travel

Figure 5 and Table 6 present summaries of idling and low-speed travel frequencies. In general, idling and low-speed travel were less likely to be reported for the smallest fleets (1-20 trucks) than for the largest fleets (501 or more trucks), but the largest fleets were the most likely to say they "never" engage in idling or low-speed travel.

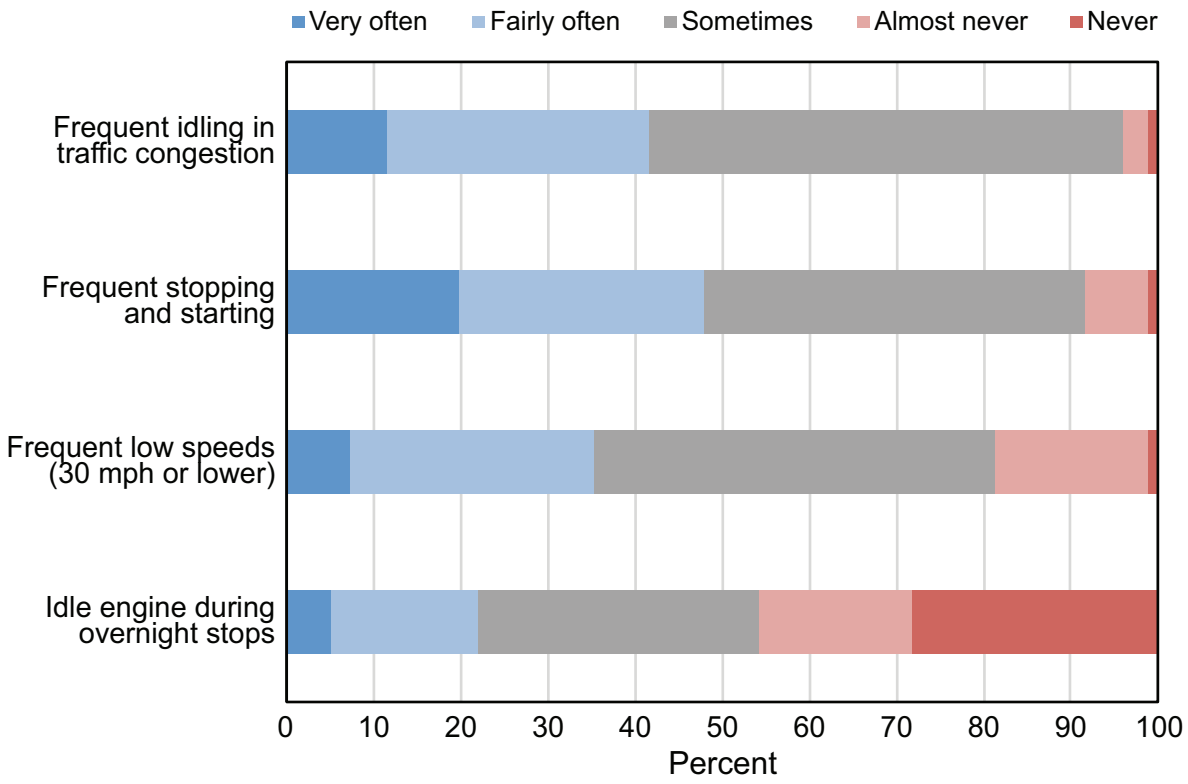

Figure 5. Idling and low-speed travel frequency (Q9), for all fleets.

Table 6
Idling and low-speed travel frequency (Q9), by fleet size.

Aspect	Fleet size	*Percent*				
		Very often	Fairly often	Sometimes	Almost never	Never
Frequent idling in traffic congestion	1-20	4.8	23.8	61.9	9.5	0.0
	21-100	9.1	27.3	63.6	0.0	0.0
	101-500	8.0	44.0	44.0	4.0	0.0
	501 or more	21.4	25.0	50.0	0.0	3.6
	All fleets	***11.5***	***30.2***	***54.2***	***3.1***	***1.0***
Frequent stopping and starting	1-20	14.3	28.6	52.4	4.8	0.0
	21-100	22.7	31.8	40.9	4.5	0.0
	101-500	20.0	28.0	40.0	12.0	0.0
	501 or more	21.4	25.0	42.9	7.1	3.6
	All fleets	***19.8***	***28.1***	***43.8***	***7.3***	***1.0***
Frequent low speeds (30 mph or lower)	1-20	4.8	19.0	47.6	28.6	0.0
	21-100	4.5	27.3	54.5	13.6	0.0
	101-500	8.0	32.0	40.0	20.0	0.0
	501 or more	10.7	32.1	42.9	10.7	3.6
	All fleets	***7.3***	***28.1***	***45.8***	***17.7***	***1.0***
Idle engine during overnight stops	1-20	4.8	9.5	4.8	38.1	42.9
	21-100	0.0	31.8	36.4	9.1	22.7
	101-500	8.0	12.0	36.0	24.0	20.0
	501 or more	7.1	14.3	46.4	3.6	28.6
	All fleets	***5.2***	***16.7***	***32.3***	***17.7***	***28.1***

Truck-based fuel-saving technologies and strategies

Figure 6 and Table 7 present summaries of truck-based fuel-saving technologies and strategies. Table 8 presents the top technologies and strategies mentioned within each category by fleet size. Generally, for all fleets the top fuel-saving technologies currently in use are: aluminum wheels (90.4%), speed limiters (84.0%), and low-rolling resistance dual tires (76.1%).

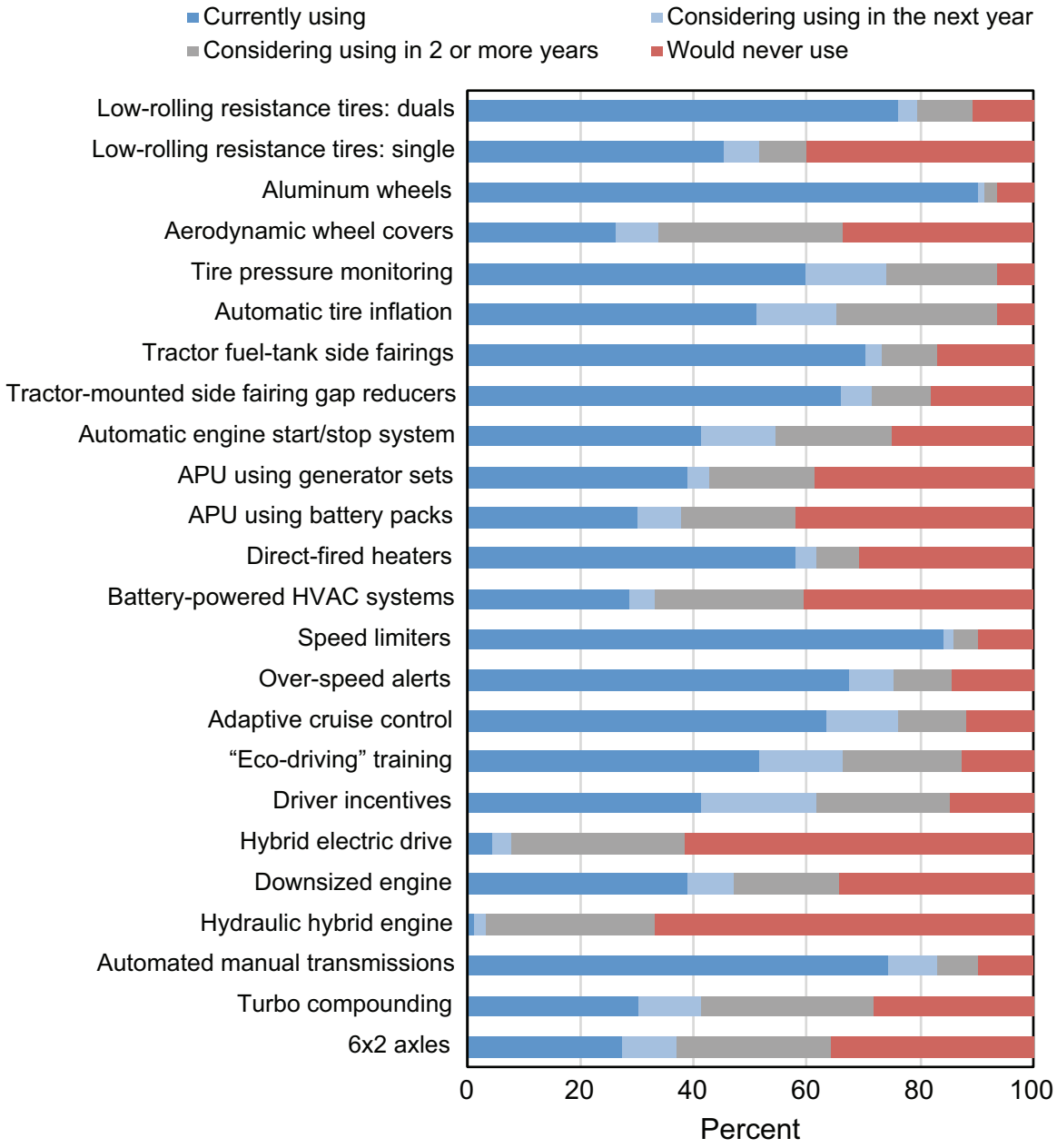

Figure 6. Truck-based fuel-saving technologies and strategies (Q10), for all fleets.

Table 7
Truck-based fuel-saving technologies and strategies (Q10), by fleet size.

Technology or strategy	Fleet size	*Percent*			
		Currently using	Considering using in the next year	Considering using in 2 or more years	Would never use
Low-rolling resistance tires: duals	1-20	60.0	0.0	20.0	20.0
	21-100	72.7	0.0	9.1	18.2
	101-500	83.3	4.2	12.5	0.0
	501 or more	84.6	7.7	0.0	7.7
	All fleets	***76.1***	***3.3***	***9.8***	***10.9***
Low-rolling resistance tires: single, new generation wide base	1-20	38.1	9.5	14.3	38.1
	21-100	38.1	0.0	4.8	57.1
	101-500	48.0	4.0	8.0	40.0
	501 or more	53.6	10.7	7.1	28.6
	All fleets	***45.3***	***6.3***	***8.4***	***40.0***
Aluminum wheels	1-20	95.0	0.0	0.0	5.0
	21-100	95.5	0.0	4.5	0.0
	101-500	91.7	0.0	0.0	8.3
	501 or more	82.1	3.6	3.6	10.7
	All fleets	***90.4***	***1.1***	***2.1***	***6.4***
Aerodynamic wheel covers	1-20	15.8	10.5	26.3	47.4
	21-100	27.3	0.0	36.4	36.4
	101-500	29.2	4.2	29.2	37.5
	501 or more	29.6	14.8	37.0	18.5
	All fleets	***26.1***	***7.6***	***32.6***	***33.7***
Tire pressure monitoring	1-20	63.2	10.5	21.1	5.3
	21-100	66.7	4.8	28.6	0.0
	101-500	44.0	24.0	12.0	20.0
	501 or more	66.7	14.8	18.5	0.0
	All fleets	***59.8***	***14.1***	***19.6***	***6.5***
Automatic tire inflation	1-20	31.6	21.1	36.8	10.5
	21-100	52.4	9.5	38.1	0.0
	101-500	45.8	8.3	29.2	16.7
	501 or more	67.9	17.9	14.3	0.0
	All fleets	***51.1***	***14.1***	***28.3***	***6.5***

(continued)

Table 7 (cont.)
Truck-based fuel-saving technologies and strategies (Q10), by fleet size.

Technology or strategy	Fleet size	*Percent*			
		Currently using	Considering using in the next year	Considering using in 2 or more years	Would never use
Tractor fuel-tank side fairings	1-20	66.7	4.8	0.0	28.6
	21-100	61.9	4.8	9.5	23.8
	101-500	72.0	4.0	20.0	4.0
	501 or more	77.8	0.0	7.4	14.8
	All fleets	***70.2***	***3.2***	***9.6***	***17.0***
Tractor-mounted side fairing gap reducers	1-20	71.4	9.5	4.8	14.3
	21-100	68.2	4.5	0.0	27.3
	101-500	60.0	8.0	20.0	12.0
	501 or more	65.4	0.0	15.4	19.2
	All fleets	***66.0***	***5.3***	***10.6***	***18.1***
Automatic engine start/stop system	1-20	35.0	5.0	15.0	45.0
	21-100	42.9	19.0	23.8	14.3
	101-500	37.5	12.5	20.8	29.2
	501 or more	48.1	14.8	22.2	14.8
	All fleets	***41.3***	***13.0***	***20.7***	***25.0***
Auxiliary power units (APU) using generator sets	1-20	45.0	5.0	15.0	35.0
	21-100	50.0	0.0	13.6	36.4
	101-500	32.0	8.0	16.0	44.0
	501 or more	30.8	3.8	26.9	38.5
	All fleets	***38.7***	***4.3***	***18.3***	***38.7***
Auxiliary power unit (APU) using battery packs	1-20	26.3	5.3	10.5	57.9
	21-100	31.8	4.5	13.6	50.0
	101-500	32.0	12.0	28.0	28.0
	501 or more	29.6	7.4	25.9	37.0
	All fleets	***30.1***	***7.5***	***20.4***	***41.9***
Direct-fired heaters	1-20	47.4	5.3	5.3	42.1
	21-100	61.9	0.0	14.3	23.8
	101-500	48.0	8.0	4.0	40.0
	501 or more	73.1	0.0	7.7	19.2
	All fleets	***58.2***	***3.3***	***7.7***	***30.8***

(continued)

Table 7 (cont.)
Truck-based fuel-saving technologies and strategies (Q10), by fleet size.

Technology or strategy	Fleet size	*Percent*			
		Currently using	Considering using in the next year	Considering using in 2 or more years	Would never use
Battery-powered HVAC systems	1-20	27.8	5.6	11.1	55.6
	21-100	36.4	0.0	18.2	45.5
	101-500	25.0	4.2	33.3	37.5
	501 or more	25.9	7.4	37.0	29.6
	All fleets	***28.6***	***4.4***	***26.4***	***40.7***
Speed limiters	1-20	55.0	5.0	5.0	35.0
	21-100	85.7	0.0	9.5	4.8
	101-500	92.0	0.0	4.0	4.0
	501 or more	96.4	3.6	0.0	0.0
	All fleets	***84.0***	***2.1***	***4.3***	***9.6***
Over-speed alerts	1-20	22.2	11.1	16.7	50.0
	21-100	63.6	4.5	22.7	9.1
	101-500	82.6	4.3	4.3	8.7
	501 or more	88.5	11.5	0.0	0.0
	All fleets	***67.4***	***7.9***	***10.1***	***14.6***
Adaptive cruise control	1-20	40.0	5.0	20.0	35.0
	21-100	54.5	13.6	27.3	4.5
	101-500	79.2	8.3	4.2	8.3
	501 or more	74.1	22.2	0.0	3.7
	All fleets	***63.4***	***12.9***	***11.8***	***11.8***
"Eco-driving" training or coaching for drivers	1-20	47.6	14.3	19.0	19.0
	21-100	59.1	18.2	13.6	9.1
	101-500	48.0	16.0	16.0	20.0
	501 or more	51.9	11.1	33.3	3.7
	All fleets	***51.6***	***14.7***	***21.1***	***12.6***
Driver incentives for improved fuel economy	1-20	35.0	20.0	35.0	10.0
	21-100	50.0	13.6	13.6	22.7
	101-500	52.0	32.0	8.0	8.0
	501 or more	29.6	14.8	37.0	18.5
	All fleets	***41.5***	***20.2***	***23.4***	***14.9***

(continued)

Table 7 (cont.)
Truck-based fuel-saving technologies and strategies (Q10), by fleet size.

Technology or strategy	Fleet size	*Percent*			
		Currently using	Considering using in the next year	Considering using in 2 or more years	Would never use
Hybrid electric drive	1-20	5.3	0.0	21.1	73.7
	21-100	9.1	0.0	27.3	63.6
	101-500	0.0	0.0	37.5	62.5
	501 or more	3.8	11.5	34.6	50.0
	All fleets	***4.4***	***3.3***	***30.8***	***61.5***
Downsized engine	1-20	35.0	0.0	20.0	45.0
	21-100	36.4	9.1	22.7	31.8
	101-500	25.0	8.3	16.7	50.0
	501 or more	55.6	14.8	14.8	14.8
	All fleets	***38.7***	***8.6***	***18.3***	***34.4***
Hydraulic hybrid engine	1-20	0.0	0.0	21.1	78.9
	21-100	0.0	0.0	22.7	77.3
	101-500	0.0	4.3	34.8	60.9
	501 or more	3.7	3.7	37.0	55.6
	All fleets	***1.1***	***2.2***	***29.7***	***67.0***
Automated manual transmissions	1-20	35.0	10.0	20.0	35.0
	21-100	86.4	4.5	9.1	0.0
	101-500	95.8	4.2	0.0	0.0
	501 or more	75.0	14.3	3.6	7.1
	All fleets	***74.5***	***8.5***	***7.4***	***9.6***
Turbo compounding	1-20	11.8	5.9	23.5	58.8
	21-100	31.8	9.1	27.3	31.8
	101-500	41.7	16.7	25.0	16.7
	501 or more	30.8	11.5	42.3	15.4
	All fleets	***30.3***	***11.2***	***30.3***	***28.1***
6x2 axles	1-20	16.7	0.0	16.7	66.7
	21-100	22.7	4.5	27.3	45.5
	101-500	36.0	12.0	24.0	28.0
	501 or more	29.6	18.5	37.0	14.8
	All fleets	***27.2***	***9.8***	***27.2***	***35.9***

Table 8
Summary of top three most frequently mentioned fuel-saving technologies or strategies within each category (Q10), by fleet size. The percentage of fleets mentioning each entry within each fleet size group is listed in parentheses.

Fleet size	Currently using	Considering using in the next year	Considering using in 2 or more years	Would never use
1-20	- Aluminum wheels (95.0) - Tractor-mounted side fairing gap reducers (71.4) - Tractor fuel-tank side fairings (66.7)	- Automatic tire inflation (21.1) - Driver incentives for improved fuel economy (20.0) - "Eco-driving" training or coaching for drivers (14.3)	- Automatic tire inflation (36.8) - Driver incentives for improved fuel economy (35.0) - Aerodynamic wheel covers (26.3)	- Hydraulic hybrid engine (78.9) - Hybrid electric drive (73.7) - 6x2 axles (66.7)
21-100	- Aluminum wheels (95.5) - Automated manual transmissions (86.4) - Speed limiters (85.7)	- Automatic engine start/stop system (19.0) - "Eco-driving" training or coaching for drivers (18.2) - Adaptive cruise control (13.6; tie) - Driver incentives for improved fuel economy (13.6; tie)	- Automatic tire inflation (38.1) - Aerodynamic wheel covers (36.4) - [4-way tie for #3]	- Hydraulic hybrid engine (77.3) - Hybrid electric drive (63.6) - Low-rolling resistance tires: single, new generation wide base (66.7)
101-500	- Automated manual transmissions (95.8) - Speed limiters (92.0) - Aluminum wheels (91.7)	- Driver incentives for improved fuel economy (32.0) - Automatic tire inflation (24.0) - Turbo compounding (16.7)	- Hybrid electric drive (37.5) - Hydraulic hybrid engine (34.8) - Battery powered HVAC (33.3)	- Hybrid electric drive (62.5) - Hydraulic hybrid engine (60.9) - Downsized engine (50.0)
501 or more	- Speed limiters (96.4) - Over-speed alerts (88.5) - Low-rolling resistance tires: duals (84.6)	- Adaptive cruise control (22.2) - 6x2 axles (18.5) - Automatic tire inflation (17.9)	- Turbo compounding (42.3) - [5-way tie for #2]	- Hydraulic hybrid engine (55.6) - Hybrid electric drive (50.0) - Auxiliary power units (APU) using generator sets (38.5)
All fleets	*- Aluminum wheels (90.4)* *- Speed limiters (84.0)* *- Low-rolling resistance tires: duals (76.1)*	*- Driver incentives for improved fuel economy (20.2)* *- "Eco-driving" training or coaching for drivers (14.7)* *- Tire pressure monitoring (14.1; tie)* *- Automatic tire inflation (14.1; tie)*	*- Aerodynamic wheel covers (32.6)* *- Hybrid electric drive (30.8)* *- Turbo compounding (30.3)*	*- Hydraulic hybrid (67.0)* *- Hybrid electric drive (61.5)* *- Auxiliary power units (APU) using battery packs (41.9)*

Speed limiters and over-speed alerts

Table 9 presents a summary of speed limiter and over-speed alert settings by fleet size. The smaller fleets reported higher than average speed limiter settings (68 mph versus 65 mph, respectively). Both the smallest and largest fleets reported slightly lower than average over-speed alert settings (69 and 68 mph respectively, versus 70 mph average).

Table 9
Speed limiters and over-speed alert settings (Q11), by fleet size.

Technology	Fleet size	*Speed setting (mph)*		
		Min	Median	Max
Speed limiters	1-20	55	68	73
	21-100	60	68	75
	101-500	62	65	77
	501 or more	62	65	72
	All fleets	***55***	***65***	***77***
Over-speed alerts	1-20	65	69	75
	21-100	62	70	80
	101-500	60	70	80
	501 or more	65	68	80
	All fleets	***60***	***70***	***80***

Trailer ownership

Table 10 presents a summary of trailer ownership rates by fleet size. Nearly all fleets included in this survey reported owning or leasing trailers. The smallest fleets reported the lowest ownership rates (81%) and the largest fleets reported the highest rates (100%).

Table 10
Own or lease any of the trailers used by heavy-duty fleet (Q12), by fleet size.

Fleet size	Percent
1-20	81.0
21-100	95.5
101-500	92.0
501 or more	100.0
All fleets	***92.7***

Trailer-based fuel-saving technologies and strategies

Figure 7 and Table 11 present summaries of trailer-based fuel-saving technologies and strategies. For all fleets that own or lease trailers, the top fuel-saving technologies currently in use are: low-rolling resistance dual tires (81.4%), aluminum wheels (71.6%), and weight-saving technologies (64.8%).

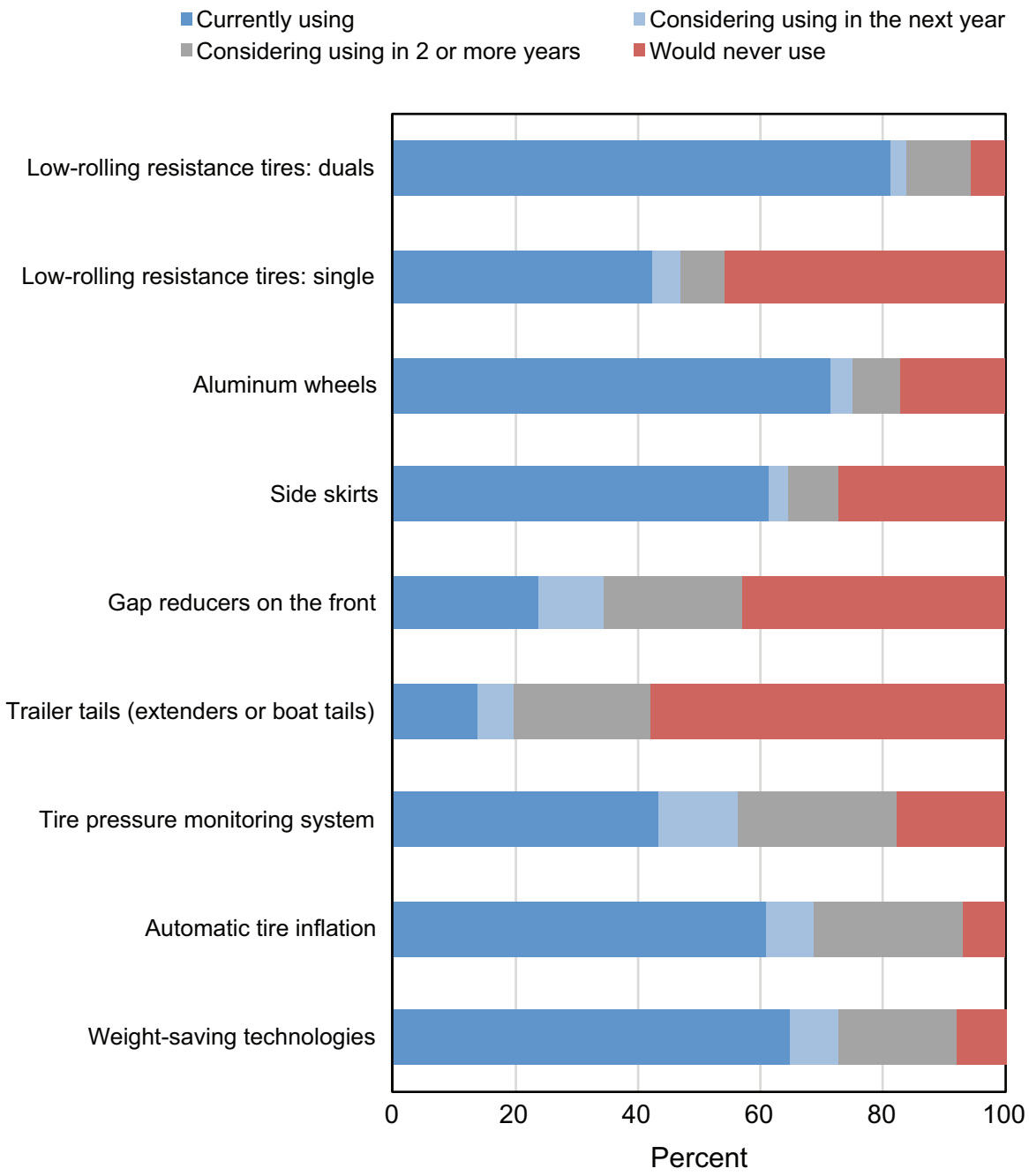

Figure 7. Trailer-based fuel-saving technologies and strategies (Q14), for all fleets.

Table 11
Trailer-based fuel-saving technologies and strategies (Q14), by fleet size.

Technology or strategy	Fleet size	*Percent*			
		Currently using	Considering using in the next year	Considering using in 2 or more years	Would never use
Low-rolling resistance tires: duals	1-20	81.3	0.0	18.8	0.0
	21-100	71.4	0.0	9.5	19.0
	101-500	81.8	4.5	13.6	0.0
	501 or more	88.9	3.7	3.7	3.7
	All fleets	***81.4***	***2.3***	***10.5***	***5.8***
Low-rolling resistance tires: single, new generation wide base	1-20	37.5	6.3	12.5	43.8
	21-100	28.6	0.0	4.8	66.7
	101-500	43.5	8.7	4.3	43.5
	501 or more	55.6	3.7	7.4	33.3
	All fleets	***42.5***	***4.6***	***6.9***	***46.0***
Aluminum wheels	1-20	87.5	0.0	0.0	12.5
	21-100	71.4	9.5	9.5	9.5
	101-500	69.6	4.3	4.3	21.7
	501 or more	64.3	0.0	14.3	21.4
	All fleets	***71.6***	***3.4***	***8.0***	***17.0***
Side skirts	1-20	46.7	0.0	13.3	40.0
	21-100	47.6	9.5	4.8	38.1
	101-500	68.2	0.0	9.1	22.7
	501 or more	74.1	3.7	7.4	14.8
	All fleets	***61.2***	***3.5***	***8.2***	***27.1***
Gap reducers on the front	1-20	28.6	0.0	14.3	57.1
	21-100	23.8	9.5	28.6	38.1
	101-500	18.2	9.1	18.2	54.5
	501 or more	25.9	18.5	25.9	29.6
	All fleets	***23.8***	***10.7***	***22.6***	***42.9***
Trailer tails (extenders or boat tails)	1-20	13.3	6.7	13.3	66.7
	21-100	9.5	4.8	33.3	52.4
	101-500	9.1	9.1	18.2	63.6
	501 or more	21.4	3.6	21.4	53.6
	All fleets	***14.0***	***5.8***	***22.1***	***58.1***

(continued)

Table 11 (cont.)
Trailer-based fuel-saving technologies and strategies (Q14), by fleet size.

Technology or strategy	Fleet size	*Percent*			
		Currently using	Considering using in the next year	Considering using in 2 or more years	Would never use
Tire pressure monitoring system	1-20	53.3	6.7	26.7	13.3
	21-100	47.6	4.8	33.3	14.3
	101-500	36.4	13.6	22.7	27.3
	501 or more	40.7	22.2	22.2	14.8
	All fleets	***43.5***	***12.9***	***25.9***	***17.6***
Automatic tire inflation	1-20	53.3	6.7	26.7	13.3
	21-100	52.4	4.8	38.1	4.8
	101-500	52.2	8.7	26.1	13.0
	501 or more	78.6	10.7	10.7	0.0
	All fleets	***60.9***	***8.0***	***24.1***	***6.9***
Weight-saving technologies	1-20	56.3	6.3	25.0	12.5
	21-100	57.1	9.5	28.6	4.8
	101-500	52.2	8.7	21.7	17.4
	501 or more	85.7	7.1	7.1	0.0
	All fleets	***64.8***	***8.0***	***19.3***	***8.0***

Payback period for fuel-saving technologies

Table 12 presents a summary of minimum payback periods for fuel-saving technologies purchased for use in heavy-duty fleets (either trucks or trailers) by fleet size. The smallest fleets were more likely to report lower minimum required payback periods when investing in fuel-saving technologies than the average fleet (medians of 12 months versus 24 months, respectively).

Table 12
Minimum payback period required (in months) for fuel-saving technologies purchased for use in heavy-duty fleet (either for trucks or trailers) (Q15), by fleet size.

Fleet size	*Payback period (months)*		
	Min	Median	Max
1-20	6	12	36
21-100	15	24	48
101-500	8	21	36
501 or more	18	24	48
All fleets	***6***	***24***	***48***

Diesel fuel price requiring new fuel-saving technologies

Table 13 presents a summary of diesel fuel prices (independent of fuel surcharges) that would require seeking out new fuel-saving technologies by fleet size. The smaller fleets reported a higher median diesel fuel price of $3.50 per gallon that would require them to seek out new fuel-saving technologies, with a lower median price of $3.00 per gallon for all other fleet sizes and the average for all fleets.

Table 13
Diesel price per gallon (in dollars; independent of fuel surcharges) that would require seeking out new fuel-saving technologies for heavy-duty fleets (Q16), by fleet size.

Fleet size	*Diesel price per gallon*
	Median
1-20	$3.50
21-100	$3.00
101-500	$3.00
501 or more	$3.00
All fleets	***$3.00***

Best return on investment with fuel-saving technologies

Figure 8 and Table 14 present summaries of fuel-saving technologies that fleets have reported are the best return on their investment. The fuel-saving technologies identified as showing the best return on investment are: aerodynamic treatments (18.8%); idle reduction technologies (15.6%); and automated manual or automatic transmissions (13.5%).

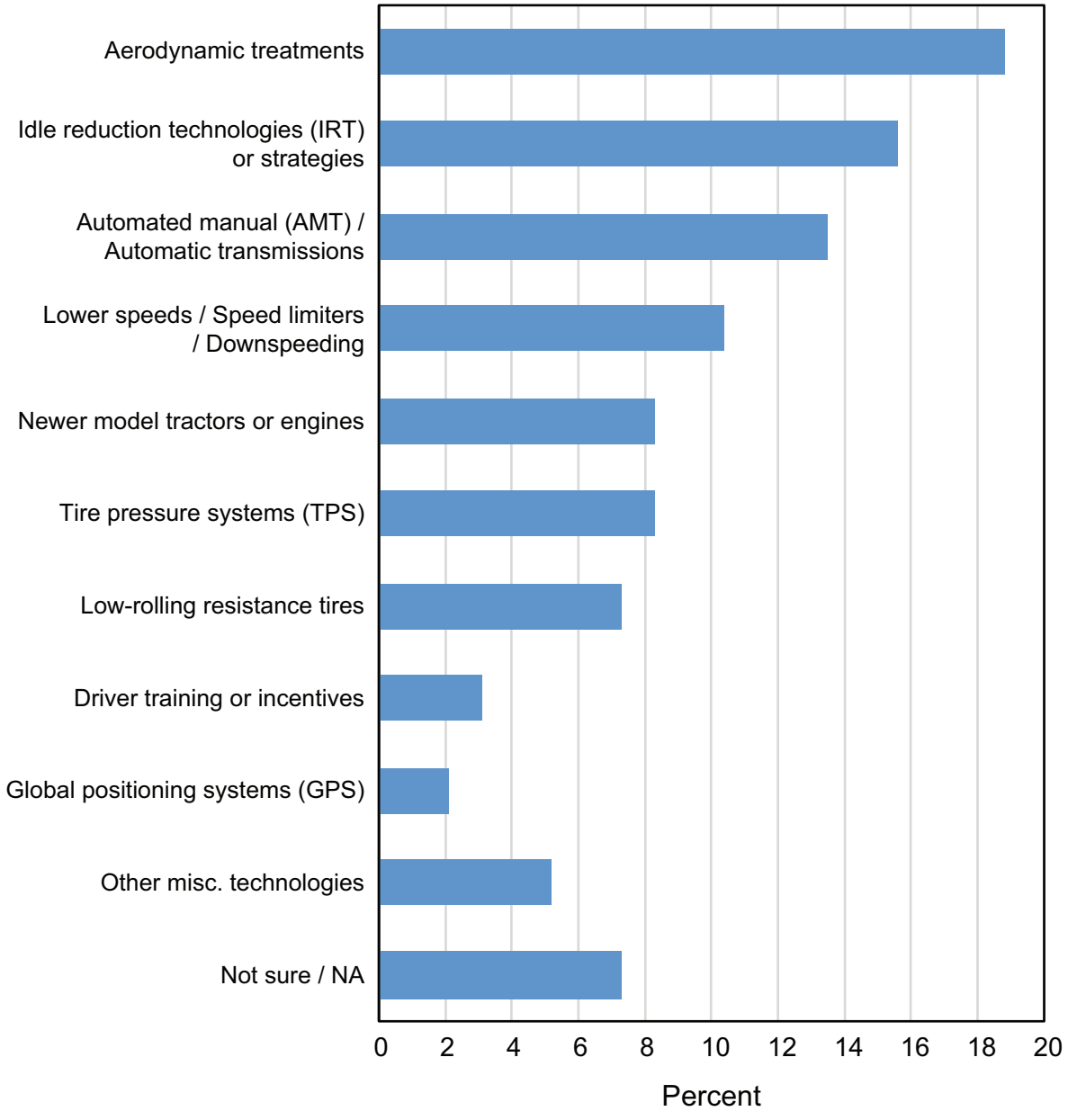

Figure 8. Fuel-saving technology showing the best return on investment (Q17), for all fleets.

Table 14
Fuel-saving technology showing the best return on investment (Q17), by fleet size.

Fuel-saving technology	*Percent*				
	1-20	21-100	101-500	501 or more	***All fleets***
Aerodynamic treatments (side fairings, trailer skirts, etc.)	4.8	22.7	24.0	21.4	***18.8***
Idle reduction technologies (IRT) or strategies	9.5	18.2	12.0	21.4	***15.6***
Automated manual (AMT) / Automatic transmissions	14.3	4.5	16.0	17.9	***13.5***
Lower speeds / Speed limiters / Downspeeding	4.8	18.2	8.0	10.7	***10.4***
Newer model tractors or engines	9.5	4.5	12.0	7.1	***8.3***
Tire pressure systems (TPS)	14.3	9.1	8.0	3.6	***8.3***
Low-rolling resistance tires	9.5	4.5	12.0	3.6	***7.3***
Driver training or incentives	4.8	4.5	4.0	0.0	***3.1***
Global positioning systems (GPS)	4.8	0.0	0.0	3.6	***2.1***
Other misc. technologies (2 or fewer responses)	14.3	4.5	0.0	3.6	***5.2***
Not sure / NA	9.5	9.1	4.0	7.1	***7.3***

Worst return on investment with fuel-saving technologies

Figure 9 and Table 15 present summaries of fuel-saving technologies that fleets have reported are the worst return on their investment. The fuel-saving technologies identified as showing the worst return on investment are: aerodynamic treatments (28.1%); low-rolling resistance tires (12.5%); and idle reduction technologies (11.5%). (A large percentage of fleet managers also stated that no fuel-saving technology showed poor return on investment, with 15.6% saying "none".)

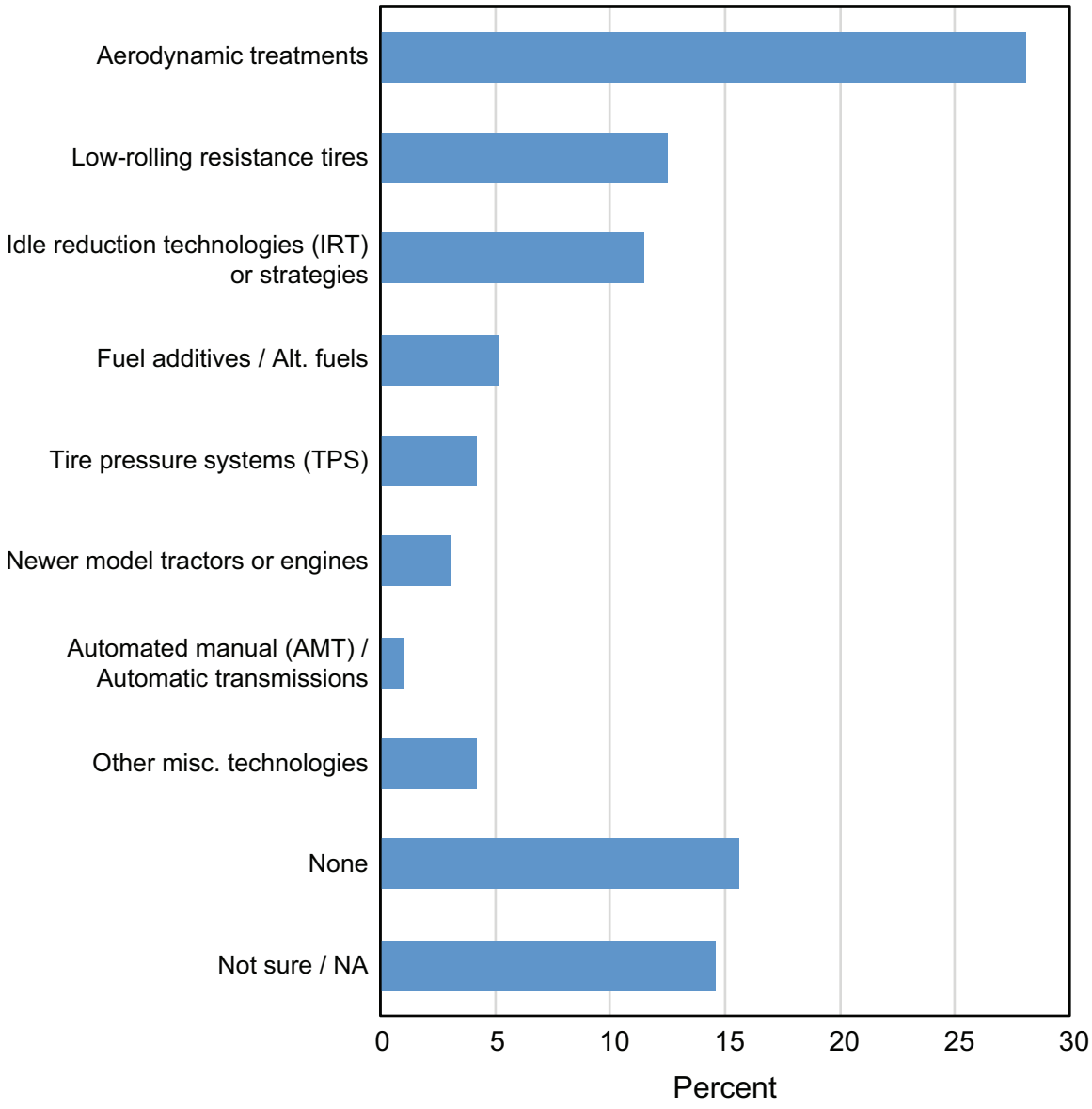

Figure 9. Fuel-saving technology showing the worst return on investment (Q18), for all fleets.

Table 15
Fuel-saving technology showing the worst return on investment (Q18), by fleet size.

Fuel-saving technology	*Percent*				
	1-20	21-100	101-500	501 or more	***All fleets***
Aerodynamic treatments (side fairings, trailer skirts, etc.)	9.5	22.7	36.0	39.3	***28.1***
Low-rolling resistance tires	4.8	22.7	16.0	7.1	***12.5***
Idle reduction technologies (IRT) or strategies	4.8	27.3	4.0	10.7	***11.5***
Fuel additives / Alt. fuels	9.5	0.0	8.0	3.6	***5.2***
Tire pressure systems (TPS)	4.8	4.5	4.0	3.6	***4.2***
Newer model tractors or engines	14.3	0.0	0.0	0.0	***3.1***
Other misc. technologies (2 or fewer responses)	0.0	4.5	8.0	7.1	***5.2***
None	28.6	9.1	8.0	17.9	***15.6***
Not sure / NA	23.8	9.1	16.0	10.7	***14.6***

Technology or policy fleet managers would like to see no longer required

Figure 10 and Table 16 present summaries of the one technology or policy that fleet managers would like to see removed or no longer required on heavy-duty trucks. Overall, the specific technologies or policies most frequently identified by heavy-duty fleet managers as those they would like to see no longer required are: exhaust aftertreatment (31.3%); emissions regulations (14.6%); and length and/or weight restrictions (4.2%). (A large percentage of fleet managers also stated that there was no one technology or policy that they would like to see removed or no longer required, with 15.6% saying "none".)

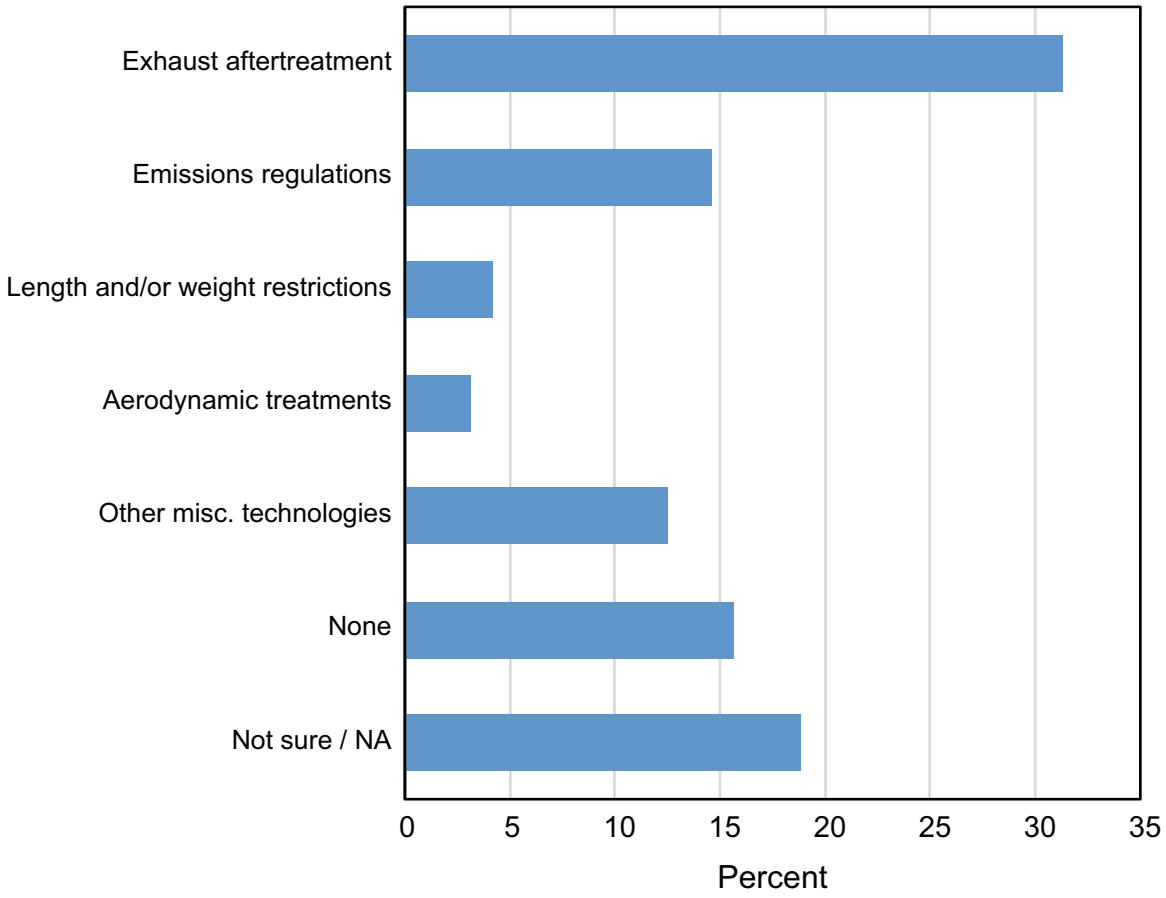

Figure 10. The one technology or policy each fleet manager would like to see removed or no longer required on heavy-duty trucks (Q19), for all fleets.

Table 16
The one technology or policy each fleet manager would like to see removed or no longer required on heavy-duty trucks (Q19), by fleet size. (Entries in italics represent subtotals for specific exhaust aftertreatments or specific emissions regulations.)

Technology or policy	*Percent*				
	1-20	21-100	101-500	501 or more	***All fleets***
Exhaust aftertreatment	14.3	45.5	44.0	21.4	***31.3***
Diesel particulate filter (DPF)	*9.5*	*22.7*	*16.0*	*10.7*	*14.6*
Exhaust aftertreatment (general)	*0.0*	*13.7*	*20.0*	*3.6*	*9.4*
Selective catalytic reduction (SCR), diesel exhaust fluid (DEF)	*0.0*	*9.1*	*0.0*	*0.0*	*2.1*
Exhaust gas recirculation (EGR)	*4.8*	*0.0*	*8.0*	*7.1*	*5.2*
Emissions regulations	19.0	18.2	8.0	14.3	***14.6***
Emissions regulations (general)	*14.2*	*4.6*	*4.0*	*7.2*	*7.3*
U.S. Environmental Protection Agency (EPA) regulations	*4.8*	*9.1*	*4.0*	*0.0*	*4.2*
California Air Resources Board (CARB) regulations	*0.0*	*4.5*	*0.0*	*7.1*	*3.1*
Length and/or weight restrictions	0.0	0.0	4.0	10.7	***4.2***
Aerodynamic treatments (side fairings, trailer skirts, etc.)	0.0	9.1	4.0	0.0	***3.1***
Other misc. technologies (2 or fewer responses)	19.0	9.1	16.0	7.1	***12.5***
None	19.0	13.6	16.0	14.3	***15.6***
Not sure / NA	28.6	4.5	8.0	32.1	***18.8***

Impact of EPA regulations on truck operating and purchasing costs

Figure 11 and Table 17 present summaries of the impact that fleet managers feel EPA heavy-duty truck emissions regulations have on truck operating costs and new truck purchase costs. While the majority of fleet managers for all fleet sizes reported that EPA heavy-duty truck emissions regulations result in "significantly higher" truck operating costs (66.7% overall), the percentage of fleet managers saying "significantly higher" consistently decreased as fleet size increased. While no consistent trend existed by fleet size regarding the impact of EPA heavy-duty truck emissions regulations on new truck purchase costs, overall a majority of fleet managers said that such costs would also be "significantly higher" (80.2%). Additionally, all fleet managers said new truck purchase costs would be "higher" or "significantly higher" due to these regulations.

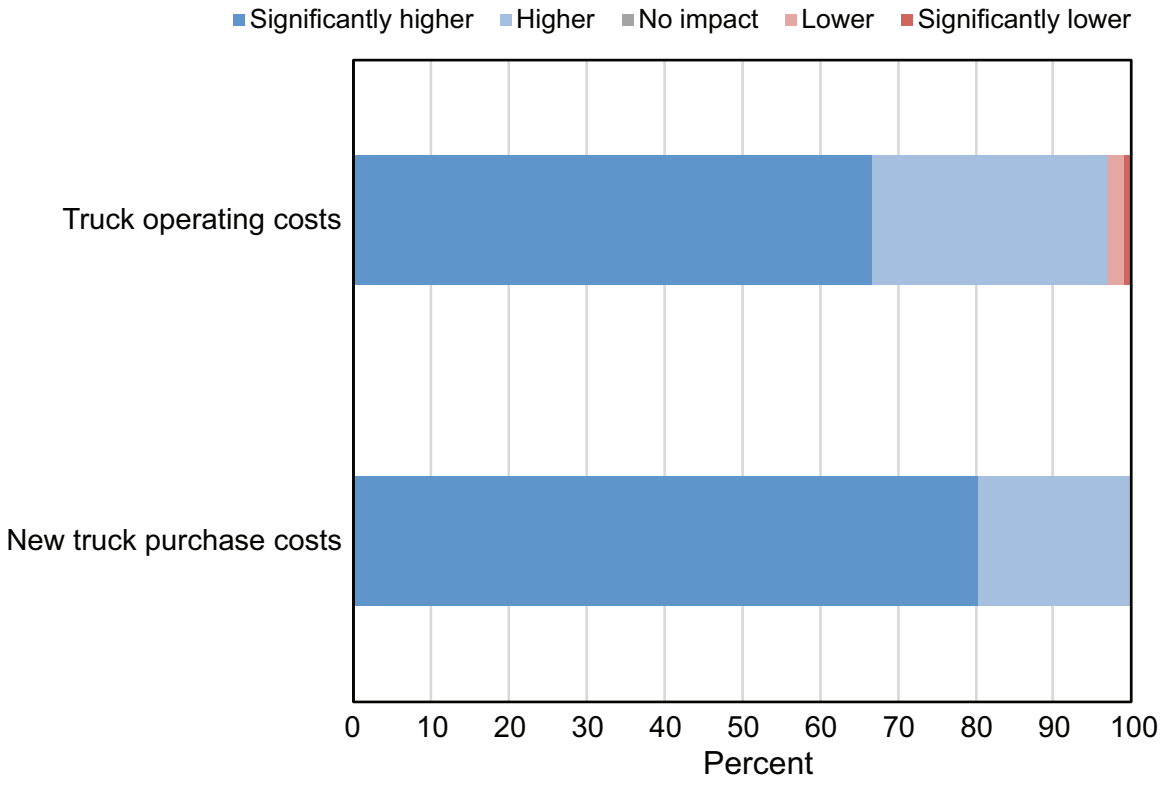

Figure 11. Impact of EPA heavy-duty truck emissions regulations on operating costs and new truck purchase costs (Q20), for all fleets.

Table 17
Impact of EPA heavy-duty truck emissions regulations on operating costs and new truck purchase costs (Q20), by fleet size.

Cost	Fleet size	*Percent*				
		Significantly higher	Higher	No impact	Lower	Significantly lower
Truck operating costs	1-20	76.2	23.8	0.0	0.0	0.0
	21-100	68.2	27.3	0.0	0.0	4.5
	101-500	64.0	32.0	0.0	4.0	0.0
	501 or more	60.7	35.7	0.0	3.6	0.0
	All fleets	***66.7***	***30.2***	***0.0***	***2.1***	***1.0***
New truck purchase costs	1-20	90.5	9.5	0.0	0.0	0.0
	21-100	72.7	27.3	0.0	0.0	0.0
	101-500	88.0	12.0	0.0	0.0	0.0
	501 or more	71.4	28.6	0.0	0.0	0.0
	All fleets	***80.2***	***19.8***	***0.0***	***0.0***	***0.0***

Fuel type usage

Figure 12 and Table 18 present summaries of fuel type usage. All fleets included in this survey currently use diesel fuel. Overall, the top three alternative fuels currently in use are biodiesel blends: B5 (49.4%), B10 (39.0%), and B20 (24.0%). The three most frequently mentioned fuels that fleet managers said they would never use are: gasoline (77.5%), dimethyl ether (DME) (70.9%), and fuel cells (hydrogen) (70.5%).

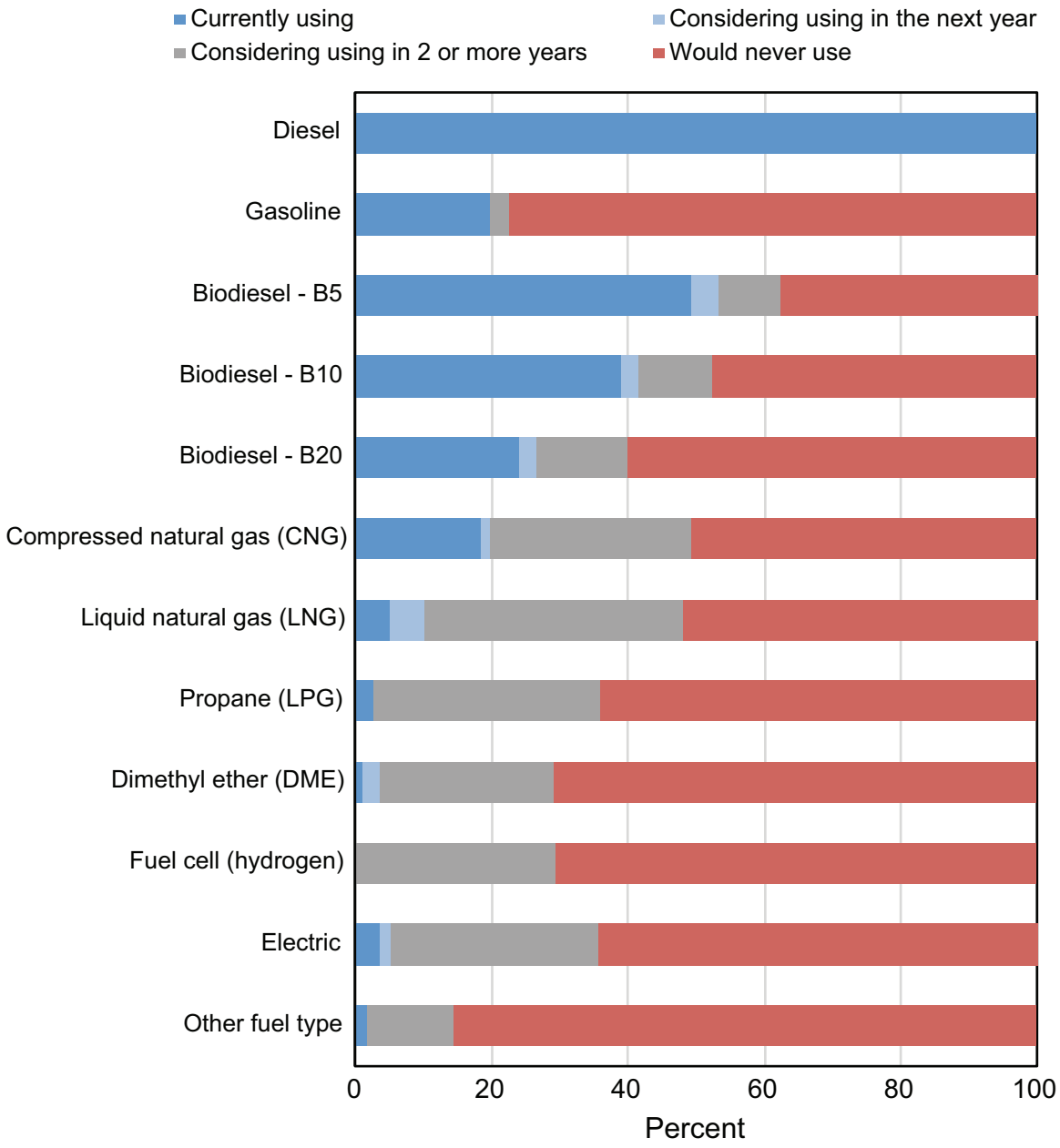

Figure 12. Fuel type usage (Q21), for all fleets.

Table 18
Fuel type usage (Q21), by fleet size. The entries in each cell represent the percentage of responses given within each fuel type (by fleet size).

Fuel type	Fleet size	*Percent*			
		Currently using	Considering using in the next year	Considering using in 2 or more years	Would never use
Diesel	1-20	100.0	0.0	0.0	0.0
	21-100	100.0	0.0	0.0	0.0
	101-500	100.0	0.0	0.0	0.0
	501 or more	100.0	0.0	0.0	0.0
	All fleets	***100.0***	***0.0***	***0.0***	***0.0***
Gasoline	1-20	14.3	0.0	0.0	85.7
	21-100	28.6	0.0	0.0	71.4
	101-500	23.8	0.0	0.0	76.2
	501 or more	13.6	0.0	9.1	77.3
	All fleets	***19.7***	***0.0***	***2.8***	***77.5***
Biodiesel – B5	1-20	40.0	0.0	6.7	53.3
	21-100	44.4	11.1	5.6	38.9
	101-500	35.0	0.0	15.0	50.0
	501 or more	70.8	4.2	8.3	16.7
	All fleets	***49.4***	***3.9***	***9.1***	***37.7***
Biodiesel – B10	1-20	31.3	12.5	6.3	50.0
	21-100	33.3	0.0	5.6	61.1
	101-500	23.8	0.0	19.0	57.1
	501 or more	59.3	0.0	11.1	29.6
	All fleets	***39.0***	***2.4***	***11.0***	***47.6***
Biodiesel – B20	1-20	21.4	7.1	14.3	57.1
	21-100	17.6	5.9	0.0	76.5
	101-500	19.0	0.0	19.0	61.9
	501 or more	34.8	0.0	17.4	47.8
	All fleets	***24.0***	***2.7***	***13.3***	***60.0***
Compressed natural gas (CNG)	1-20	0.0	0.0	25.0	75.0
	21-100	20.0	0.0	15.0	65.0
	101-500	9.5	0.0	38.1	52.4
	501 or more	37.5	4.2	37.5	20.8
	All fleets	***18.5***	***1.2***	***29.6***	***50.6***

(continued)

Table 18 (cont.)
Fuel type usage (Q21), by fleet size. The entries in each cell represent the percentage of responses given within each fuel type (by fleet size).

Fuel type	Fleet size	*Percent*			
		Currently using	Considering using in the next year	Considering using in 2 or more years	Would never use
Liquid natural gas (LNG)	1-20	0.0	0.0	20.0	80.0
	21-100	0.0	0.0	36.8	63.2
	101-500	0.0	9.1	40.9	50.0
	501 or more	17.4	8.7	47.8	26.1
	All fleets	***5.1***	***5.1***	***38.0***	***51.9***
Propane (LPG; liquefied petroleum gas)	1-20	0.0	0.0	26.7	73.3
	21-100	0.0	0.0	21.1	78.9
	101-500	0.0	0.0	23.8	76.2
	501 or more	8.7	0.0	56.5	34.8
	All fleets	***2.6***	***0.0***	***33.3***	***64.1***
Dimethyl ether (DME)	1-20	0.0	0.0	6.7	93.3
	21-100	5.3	0.0	10.5	84.2
	101-500	0.0	9.1	31.8	59.1
	501 or more	0.0	0.0	43.5	56.5
	All fleets	***1.3***	***2.5***	***25.3***	***70.9***
Fuel cell (hydrogen)	1-20	0.0	0.0	26.7	73.3
	21-100	0.0	0.0	15.8	84.2
	101-500	0.0	0.0	33.3	66.7
	501 or more	0.0	0.0	39.1	60.9
	All fleets	***0.0***	***0.0***	***29.5***	***70.5***
Electric	1-20	0.0	0.0	20.0	80.0
	21-100	5.0	0.0	15.0	80.0
	101-500	0.0	0.0	33.3	66.7
	501 or more	8.7	4.3	47.8	39.1
	All fleets	***3.8***	***1.3***	***30.4***	***64.6***
Other fuel type	1-20	9.1	0.0	9.1	81.8
	21-100	0.0	0.0	6.3	93.8
	101-500	0.0	0.0	18.8	81.2
	501 or more	0.0	0.0	16.7	83.3
	All fleets	***1.8***	***0.0***	***12.7***	***85.5***

Advantages of fuel types being considering for use

Table 19 presents a summary of the *advantages* identified by fleet managers for each fuel type being considered for use for all fleets. (Due to the small number of cases within each fuel type and advantage combination, no analysis was performed by fleet size.) The three most frequently identified advantages for each alternative fuel being considered for use are: lower cost or cheaper overall, cleaner or reduced emissions, and better availability. (Fleet managers also frequently reported not being aware of any specific advantages, either saying "none" or "do not know.")

Table 19
Advantages of each alternative fuel type considering for use (Q23), for all fleets. The entries in each cell represent the percentage of responses given within each fuel type.

Advantage	*Fuel type*										
	Gasoline	B5	B10	B20	CNG	LNG	LPG	DME	Fuel cell	Electric	Other fuel
Lower cost / Cheaper	50.0	33.3	20.0	36.4	52.0	45.5	29.2	14.3	20.0	20.8	13.3
Cleaner / Reduced emissions			10.0	9.1	24.0	24.2	33.3	28.6	40.0	37.5	26.7
Better availability	50.0				8.0	9.1	12.5	19.0			
Renewable		11.1							5.0	16.7	
North American production						3.0	4.2	4.8	5.0		
Longer range						6.1					
Other misc. advantage		11.1	30.0	18.2	12.0	6.1	12.5	4.8		8.3	13.3
None		22.2	20.0	18.2	4.0	3.0					13.3
Do not know		22.2	20.0	18.2		3.0	8.3	28.6	30.0	16.7	33.3

Disadvantages of fuel types considering for use

Table 20 presents a summary of the *disadvantages* identified by fleet managers for each fuel type being considered for use for all fleets. (Due to the small number of cases within each fuel type and disadvantage combination, no analysis was performed by fleet size.) The three most frequently identified disadvantages for each alternative fuel being considered for use are: low availability or low/no infrastructure, increased cost, and lower fuel economy. (Fleet managers also frequently reported other miscellaneous disadvantages that were uncategorized, or said that they "do not know" about any specific disadvantages.)

Table 20
Disadvantages of each alternative fuel type considering for use (Q24), for all fleets. The entries in each cell represent the percentage of responses given within each fuel type.

Disadvantage	*Fuel type*										
	Gasoline	B5	B10	B20	CNG	LNG	LPG	DME	Fuel cell	Electric	Other fuel
Low availability / Low (or no) infrastructure		22.2	11.1	10.0	34.8	28.1	25.0	30.0	20.0	12.5	23.1
Increased cost		22.2		10.0	21.7	28.1	12.5	20.0	30.0	29.2	
Lower fuel economy	50.0	11.1	11.1	10.0			8.3				
Cold weather performance (reduced)		11.1	22.2	30.0							
Filter plugging with fuel			11.1	20.0							
Low availability of maintenance techs					8.7	6.3	8.3			4.2	
Lower power					4.3	3.1	8.3			4.2	
Battery life is too short										8.3	
Other misc. disadvantage	50.0	33.3	44.4	20.0	26.1	31.3	25.0	10.0	20.0	33.3	30.8
Do not know					4.3	3.1	12.5	40.0	30.0	8.3	46.2

Private fueling facilities

Table 21 presents a summary of private diesel fueling facility ownership by fleet size. As expected, ownership of private diesel fueling facilities increased as fleet size increased. While the median for all fleets overall and for medium-sized fleets was one private fueling facility, smaller fleets generally owned none, and the median rate for the largest fleets was four private facilities per fleet.

Table 21
Number of private diesel fueling facilities owned or operated (Q25), by fleet size.

Fleet size	*Number of private diesel fueling facilities*		
	Min	Median	Max
1-20	0	0	1
21-100	0	1	3
101-500	0	1	50
501 or more	0	4	1,200
All fleets	***0***	***1***	***1,200***

Payback period for switching heavy-duty fleet to an alternative fuel

Table 22 presents a summary of minimum payback periods for switching heavy-duty fleets to an alternative fuel by fleet size. The smaller fleets were more likely to report a lower minimum required payback period of 12 months (median) when considering switching their heavy-duty fleet to an alternative fuel versus 24 months as reported by medium and large fleets, and for all fleets overall.

Table 22
Minimum payback period required (in months) for switching heavy-duty fleet to an alternative fuel (Q26), by fleet size.

Fleet size	*Payback period (months)*		
	Min	Median	Max
1-20	0	12	60
21-100	12	24	60
101-500	0	24	120
501 or more	12	24	48
All fleets	***0***	***24***	***120***

Key Findings

Fuel economy and freight hauling

- The median (50th percentile) heavy-duty fleet fuel economy reported in this study was 6.5 mpg, with the median value varying by 0.5 mpg between all fleet sizes. This fuel economy was achieved with the typical fleet hauling 2.1 million tons of cargo 10 million miles annually (both are median values across all fleets).

Fuel costs and pricing

- The median percentage of operating costs spent on fuel was 24 percent, but ranged as high as 30 percent for the smallest fleets, and as low as 16 percent for the largest fleets.
- On average, the smallest fleets said that the price of diesel per gallon (not including surcharges) that would require seeking out fuel-saving technologies was $3.50, while all other fleets (and all fleets overall) said $3.00.

Fuel type usage

- Every heavy-duty fleet included in this survey currently uses diesel fuel.
- The most common alternative fuels in use are biodiesel blends (in order of usage): B5, B10, and B20.
- While most fleets indicated they would never use gasoline (77.5%), it was also the most common non-diesel/biodiesel fuel currently in use (19.7%).

Perceived advantages and disadvantages of alternative fuels

- When considering using alternative fuels, fleet managers generally see the top advantages of these fuels as: lower in cost, cleaner (reduced emissions), and better availability.
- On the other hand, fleet managers also see the disadvantages of certain alternative fuels as: having low (or no) availability or infrastructure for distribution, increased cost overall, and possibly lowering fuel economy for their fleet.

Fuel-saving technologies and strategies

- For fleets employing fuel-saving technologies or strategies on the truck-tractor, the most common are: aluminum wheels, speed limiters, and low-rolling resistance dual tires.
- The vast majority (92.7%) of fleets participating in this survey own or lease trailers. For those fleets, the most common fuel-saving technologies or strategies employed on their trailers are: low-rolling resistance dual tires, aluminum wheels, and weight-saving technologies.

Payback period when investing in new technologies or alternative fuels

- The smallest fleets require faster payback periods than medium or large fleets when investing in fuel-saving technologies purchased for use in heavy-duty fleets (12 months for the smallest fleets, versus 24 months for all others).
- A nearly identical trend was found for required minimum payback periods when considering switching their heavy-duty fleet to an alternative fuel; the smallest fleets require payback within 12 months, while all other fleet sizes require 24 months.

Return on investments in technologies

- Fleet managers identified several fuel-saving technologies or strategies that provide the best return on their investment, with the top three being: aerodynamic treatments; idle reduction technologies or strategies; and automated manual or automatic transmissions.
- Conversely, fleet managers also identified several fuel-saving technologies or strategies that provide the worst return on their investment, with the top mentions being: aerodynamic treatments; low-rolling resistance tires; and idle reduction technologies or strategies.

Impact of regulations and policies

- The specific technologies or policies fleet managers would like to see no longer required for heavy-duty fleets are: exhaust aftertreatment; emissions regulations; and length and/or weight restrictions.
- Nearly all fleet managers (96.9%) feel that EPA heavy-duty emissions regulations will lead to higher or significantly higher truck operating costs.
- All fleet managers surveyed feel that EPA heavy-duty emissions regulations will lead to higher or significantly higher new truck purchase costs.

Summary

The main findings are as follows:

- The 96 fleets surveyed for this study operate a combined total of just over 114,500 truck-tractors and approximately 350,000 trailers, hauling a total of 9 billion tons of freight across 1.8 billion miles annually.
- The median heavy-duty fleet fuel economy reported in this study was 6.5 mpg, with the typical fleet hauling 2.1 million tons of cargo 10 million miles annually.
- Every heavy-duty fleet included in this survey currently uses diesel fuel, with biodiesel blends (B5, B10, and B20) being the most common alternative fuels in use.
- Fleet managers generally see the top advantages of specific alternative fuels as: lower in cost, cleaner (reduced emissions), and more available than other alternative fuels; they see the disadvantages of specific alternative fuels as: having low (or no) availability or infrastructure for distribution, increased cost overall, and possibly lowering fuel economy for their fleet.
- The most common fuel-saving technologies on the truck-tractor were: aluminum wheels, speed limiters, and low-rolling resistance dual tires; the most common fuel-saving technologies on trailers were: low-rolling resistance dual tires, aluminum wheels, and weight-saving technologies.
- The smallest fleets require faster payback periods than medium and large fleets when investing in fuel-saving technologies or when considering switching their heavy-duty fleet to an alternative fuel.
- Nearly all fleet managers feel that EPA heavy-duty emissions regulations will lead to higher or significantly higher truck operating costs, and all fleet managers surveyed feel that such regulations will lead to higher or significantly higher new truck purchase costs.

References

AFDC [Alternative Fuels Data Center]. (2012a). *Types of Vehicles by Weight Class*. Available at: http://www.afdc.energy.gov/data/10381

AFDC [Alternative Fuels Data Center]. (2012b). *Vehicle Weight Classes & Categories*. Available at: http://www.afdc.energy.gov/data/10380

ATA [American Trucking Associations]. (2016). *American Trucking Trends 2016*. Arlington, VA: Author.

ATA [American Trucking Associations]. (2015). *U.S. Freight Transportation Forecast to 2026*. Arlington, VA: Author.

ATRI [American Transportation Research Institute]. (2016). *An Analysis of the Operational Costs of Trucking: 2016 Update*. Arlington, VA: Author.

EPA/NHTSA [Environmental Protection Agency and National Highway Traffic Safety Administration]. (2016a). *Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles - Phase 2* (prepublication version). Available at: https://www3.epa.gov/otaq/climate/documents/2016-08-ghg-hd-final-rule-phase2-preamble.pdf

EPA/NHTSA [Environmental Protection Agency and National Highway Traffic Safety Administration]. (2016b). *Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles - Phase 2 Regulatory Impact Analysis*. Available at: https://www3.epa.gov/otaq/climate/documents/420r16900.pdf

EPA/NHTSA [Environmental Protection Agency and National Highway Traffic Safety Administration]. (2012). *2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Final Rule*. Federal Register 77:199 (October 15, 2012), pp. 62623-63200. Available at: http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/2017-25_CAFE_Final_Rule.pdf

Sivak, M. and Schoettle, B. (2016). *Transportation emissions in the context of emissions from other economic sectors: 1990-2014* (Technical Report No. SWT-2016-9). Ann Arbor: University of Michigan Transportation Research Institute.

United Nations. (2015). *Adoption of the Paris agreement. United Nations Framework Convention on Climate Change*. Available at: https://unfccc.int/documentation/documents/advanced_search/items/6911.php?priref=600008831

Appendix: Questionnaire

Heavy-duty truck fleet fuel economy and fuel usage survey

Thank you for participating in our truck fleet fuel economy and fuel usage survey. We are investigating current and future approaches to improving fuel economy in heavy-duty truck fleets (FHWA classes 7 and 8). This research is being co-sponsored by the University of Michigan Transportation Research Institute (UMTRI), ExxonMobil, and the American Transportation Research Institute (ATRI).

Your input and opinions are valuable to this research. To show our appreciation, each participant who completes this survey will receive a copy of the final report with aggregate survey results at the conclusion of the project later this summer. **At no point will any individual responses be publicized or distributed.**

If you manage truck fleets based outside of the United States, please answer only for your U.S. fleet (including any cross-border routes into Canada or Mexico) when completing this survey.

If you have any questions or problems while completing this survey, please contact:

Brandon Schoettle
Project Manager
University of Michigan Transportation Research Institute (UMTRI)
(734) 615-6522
basc@umich.edu

1) Please indicate your fleet type:

[Select only one response.]

	Private
	For-hire
	Other fleet type (please describe): _____

2) How many Class 7 and Class 8 truck-tractors do you own or lease?

[Enter total number of Class 7 and Class 8 truck-tractors.]

[If zero, go to disqualification page]

3) What percentage of your heavy-duty fleet does each of the following apply to?

[Enter 0-100% for each type -- total should equal 100.]

	Cargo is "cubed out": filled to maximum volume but not maximum weight capacity
	Cargo "weighs out": filled to maximum weight capacity but not maximum volume
	Neither: cargo is typically not loaded to maximum volume or weight capacity
	Both: cargo is typically loaded to both weight and volume limits
	NOT APPLICABLE (such as with specialized trailers like tankers, cement trucks, or buses)
100%	***Total***

4) What percentage of your operations involve the following activities?

[Enter 0-100% for each type -- total should equal 100%.]

	Local/regional operations with same day returns
	Local/regional operations with overnight stay
	Long-haul with overnight stay
	Long-haul using team drivers
	Other (please describe):_____
100%	***Total***

5) What is your average overall fleet fuel economy for your truck-tractors (approximately or IFTA-based)?

[Enter fuel economy in mpg.]

6) What is the approximate total annual tonnage moved by your heavy-duty fleet?

[Enter annual tons of cargo.]

7) What is the approximate total annual mileage driven by your heavy-duty fleet?

[Enter annual mileage.]

8) What percentage of your overall operating costs is fuel related?

[Enter 1-100%.]

%

9) How often do the trucks in your fleet do the following?

[Please select one response per row.]	Very often	Fairly often	Sometimes	Almost never	Never
Frequent idling in traffic congestion					
Frequent stopping and starting					
Frequent low speeds (30 mph or lower)					
Idle engine during overnight stops					

10) Please select a response in the appropriate column relating to the following fuel-saving truck-tractor technologies or strategies you are currently using or considering using.

[Please select one response per row.]	Currently using	Considering using in:		Would never use
		Next year	2+ years	
Low rolling resistance tires: Dual tires				
Low rolling resistance tires: Singles, new generation wide base				
Aluminum wheels				
Aerodynamic wheel covers				
Tire pressure monitoring				
Automatic tire inflation				
Tractor fuel-tank side fairings				
Tractor-mounted side fairing gap reducers				
Automatic engine start/stop system				
Auxiliary power units (APU) using generator sets				
Auxiliary power units (APU) using battery packs				
Direct-fired heaters				
Battery-powered HVAC system				
Speed limiters				
Over-speed alert				
Adaptive cruise control				
"Eco-driving" training or coaching for drivers				
Driver incentives for improved fuel economy				
Hybrid electric drive				
Downsized engine				
Hydraulic hybrid engine				
Automated manual transmissions				
Turbo compounding				
6x2 axles				

[ONLY ASK IF MENTIONED IN PREVIOUS QUESTION]

11) What speed do you (or would you) use for speed limiters or over-speed alerts?

[Enter speed.]

	Speed limiters/governors
	Over-speed alert

12) Do you own or lease any of the TRAILERS used by your heavy-duty fleet?

[Enter speed.]

	Yes
	No ***[SKIP Q13, Q14]***

13) Please indicate how many of the following types of trailers you own or lease.

Quantity	**Equipment type**
	28'/33' Trailers
	45' Trailers
	48' Trailers
	53' Trailers
	Other (please specify)_____

[ONLY ASK IF TRAILERS IN FLEET >0 FROM PREVIOUS QUESTION]

14) Please select a response in the appropriate column relating to the following fuel-saving trailer technologies or strategies you are currently using or considering using.

[Please select one response per row.]	Currently using	Considering using in:		Would never use
		Next year	2+ years	
Low rolling resistance tires: Dual tires				
Low rolling resistance tires: Singles, new generation wide base				
Aluminum wheels				
Side skirts				
Gap reducers on the front				
Trailer tails (either extenders or boat tails)				
Tire pressure monitoring system				
Automatic tire inflation system				
Weight-saving technologies				

15) What is the minimum required payback period, in months, for the fuel-saving technologies purchased for use in your heavy-duty truck fleet (either for truck-tractors or trailers)?

[Enter months.]

16) Independent of fuel surcharges, what diesel price per gallon would require you to seek out new fuel-saving technologies for use in your heavy-duty truck fleet?

	$ / gallon

17) In general, for new fuel-saving technology that you have actually deployed in your heavy-duty fleet over the last few years, what technology has shown the best return on your investment?

List technology and explain: _____

18) In general, for new fuel-saving technology that you have actually deployed in your heavy-duty fleet over the last few years, what technology has shown the worst return on your investment?

List technology and explain: _____

19) What is the ONE technology or policy you would like to see removed or no longer required on today's heavy-duty trucks?

List technology or policy and explain: _____

20) Please indicate what impact the U.S. EPA heavy-duty truck emissions regulations are/will have on:

[Please select one response per row.]	Significantly higher	Higher	No impact	Lower	Significantly lower
Truck operating costs					
New truck purchase costs					

21) Please indicate which of the following fuels you are currently using or considering using.

[Please select one response per row.]	Currently using	Considering using in:		Would never use
		Next year	2+ years	
Diesel				
Gasoline				
Biodiesel – B5				
Biodiesel – B10				
Biodiesel – B20				
Compressed natural gas (CNG)				
Liquid natural gas (LNG)				
Propane (LPG; liquefied petroleum gas)				
Dimethyl ether (DME)				
Fuel cell (hydrogen)				
Electric				
Other fuel type				

22) Please list the other fuel type you are considering: _____

[INSERT FUELS "CONSIDERING" IN PREVIOUS Q21/Q22]

23) What are the major advantages of [*fuels "considering" in Q21/Q22*]?

List advantages: _____

24) What are the major disadvantages of [*fuels "considering" in Q21/Q22*]?

List disadvantages: _____

25) Please indicate the number of private diesel fueling facilities you own or operate.

☐

26) To consider switching your heavy-duty trucks to an alternative fuel, what is the minimum required payback period, in months?

[Enter months.]

☐

27) Thank you for taking the time to complete this survey!

To receive a copy of the final report and survey results:

Please enter your name, company name, and either your mailing address to receive a paper copy or your email address to receive an electronic copy (PDF file).

If you do not wish to supply this information to receive a copy of the final report, click "Next" to skip this question.

Name:	
Company:	
Address:	
City:	
State/Province:	
ZIP/Postal code:	
Country:	
Email:	

Thank you for participating in this research project!