



Heavy-Duty Innovation: Energy, Automation, and Technology in the Trucking Sector

- Commercial trucking is a critical component of U.S. economic competitiveness. Despite only accounting for 4 percent of vehicles on the road, long-haul trucks move more than 70 percent of all freight—\$725 billion every year—in the United States and account for roughly 13 percent of total U.S. petroleum consumption.
- The U.S. transportation sector relies on oil for 92 percent of its total energy consumption. This dependence leaves the U.S. economy vulnerable to volatile price conditions and an unpredictable global oil market. Increasing efficiency is one of the most effective tools for decreasing the oil intensity of the U.S. economy, and thereby enhancing economic and national security.
- Oil dependence in the trucking sector can be reduced by adopting new technologies that lead to a more modern and efficient trucking sector. New technologies include vehicle design changes, advanced driver assistance systems (ADAS), platooning and connected vehicles, and eventually highly autonomous trucks. Once deployed, these technologies have the potential to upend an industry that has yet to fully experience the digital revolution that has reframed how many other industries operate.
- As the economy grows and evolves, so must the trucking sector. Due to changing consumer preferences, less-than-truckload (LTL) transport is the fastest growing freight mode in the trucking sector. SAFE modeling estimates that legislation allowing trucks to pull twin-33 foot trailers could save more than 23 billion gallons of diesel by 2050.
- The integration of connected vehicle technology into the trucking sector presents enormous potential for creating safer and more efficient roadways. SAFE modeling estimates that platooning technology—enabled by connectivity—could save more than 20 billion cumulative gallons of diesel by 2050 in the heavy-duty freight sector.
- SAFE's analysis also examines the employment implications of emerging vehicle technologies, and finds that while job displacement in the trucking sector is possible, new jobs will be created and those who are currently employed are unlikely to lose their jobs before retirement.
- The trucking industry is likely to be an early implementer of autonomous vehicle technology because freight transportation presents a more predictable and less complex driving environment than urban roads. Although the timeline for commercialization is unclear, autonomous trucks promise safer roadways, solutions to an industry experiencing rapid growth amid chronic labor shortages, and efficiency gains whose savings can be passed on to U.S. consumers. Regulators have an important role to play in ensuring that policy allows this important industry to innovate in ways that will save lives, reduce costs while meeting growing consumer demand, and save fuel.

Introduction

Every day, millions of Americans rely on oil to power the cars that take them to places of work and the trucks that deliver goods to their local stores. Oil's importance to the nation's economy cannot be overstated. It comprises nearly 40 percent of U.S. primary energy demand overall.¹ More than 70 percent of the country's total oil consumption flows directly into the transportation sector.² As a fuel source, oil monopolizes this sector almost entirely, and its influence is set to endure for the foreseeable future.

As U.S. oil production growth reached record levels over the past decade, some have claimed that “energy independence” is within our grasp. This view is unrealistic and shortsighted. While increased U.S. oil production has undoubtedly contributed to the country's economic recovery—creating jobs and reducing the trade deficit—one thing it cannot do is singlehandedly make America energy secure.

Solutions designed to enhance American energy security must begin with increasing the number of fuel and technology options available in the transportation sector. The transformation of this sector is often discussed in terms of personal mobility and passenger vehicles. However, the trucks on our nation's highways are underappreciated as a critical component of U.S. economic competitiveness and new solutions that promise to make meaningful advances in energy security should be a national priority.

This paper outlines a variety of trucking technologies and innovations that are either currently available or under development, and offers new modeling on the potential benefits of these technologies once commercially deployed. These innovations are the key to modernizing the freight and logistics industries, but many of them are constrained by outdated regulatory policy or are only permitted in a small number of states. Regulators cannot afford to take this sector for granted—SAFE's recommendations for the future of trucking outline straightforward regulatory and policy measures which will save lives, put money back in the pockets of consumers, and reduce the nation's oil dependence.

Trucking Industry Background

Trucks are instrumental in fostering economic growth. They enable the movement of nearly 70 percent of the nation's freight, representing more than \$725 billion in revenue on an annual basis.³ The industry is comprised of more than 1 million for-hire and private carriers who employ 7.3 million people directly or in related industries.⁴ In total, there are more than 3.5 million long-haul trucks each traveling, on average, more than 68,000 miles every year.⁵ As shown in Figure 1, freight levels are forecast to grow more than 40 percent by 2045 alongside the evolution and expansion of the U.S. economy.⁶

¹ SAFE analysis based on data from EIA.

² Id.

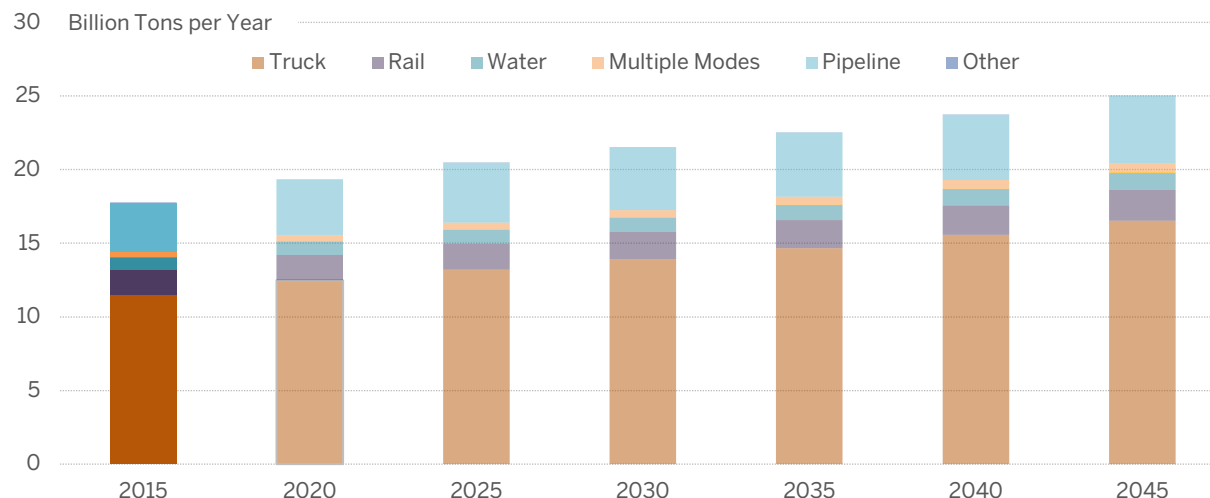
³ American Trucking Associations, “Reports, Trends & Statistics.”

⁴ Id.

⁵ Id.; and AFDC, “Average Annual Vehicle Miles Traveled (Per Vehicle) By Major Vehicle Categories,” June 2015.

⁶ FHWA, “Freight Analysis Framework Data Tabulation Tool,” July 13, 2017.

FIGURE 1 · U.S. Freight Forecast, 2015 - 2045



Note: Chart excludes 'Air' data series.

Source: Federal Highway Administration

Truck Classifications

In the United States, trucks are classified by Gross Vehicle Weight Ratings (GVWR). Within the GVWR ratings, there are three additional categories: light, medium, and heavy duty. As vehicle weight and size increase, fuel economy generally decreases. With millions of heavy-duty trucks moving 10.5 billion tons of freight in the United States annually, efficiency improvements in heavy-duty vehicles will be instrumental in reducing oil dependence in the trucking sector.⁷

FIGURE 2 · Vehicle Classifications

Gross Vehicle Weight Rating (GVWR) (lbs)	Vehicle Class (lbs)	GVWR Category	Example
<6,000	Class 1: <6,000	Light Duty	Ford F-150
10,000	Class 2: 6,001 – 10,000		
14,000	Class 3: 10,001– 14,000	Medium Duty	Dodge Ram 5500 flatbed
16,000	Class 4: 14,001 – 16,000		
19,500	Class 5: 16,001 – 19,500		
26,000	Class 6: 19,501 – 26,000	Heavy Duty	Semi-Truck
33,000	Class 7: 26,001 – 33,000		
>33,000	Class 8: > 33,001		

Reducing Oil Dependence in the Trucking Industry

Medium- and heavy-duty vehicles represent a sizable portion of U.S. transportation-related oil demand. For example, trucks consume roughly 15 percent of U.S. petroleum, even though they represent only nine percent of highway travel and four percent of the vehicles on the road.⁸ In total, medium- and heavy-duty trucks accounted for 2.8 million barrels per day (mbd) of U.S. oil consumption in 2014.⁹

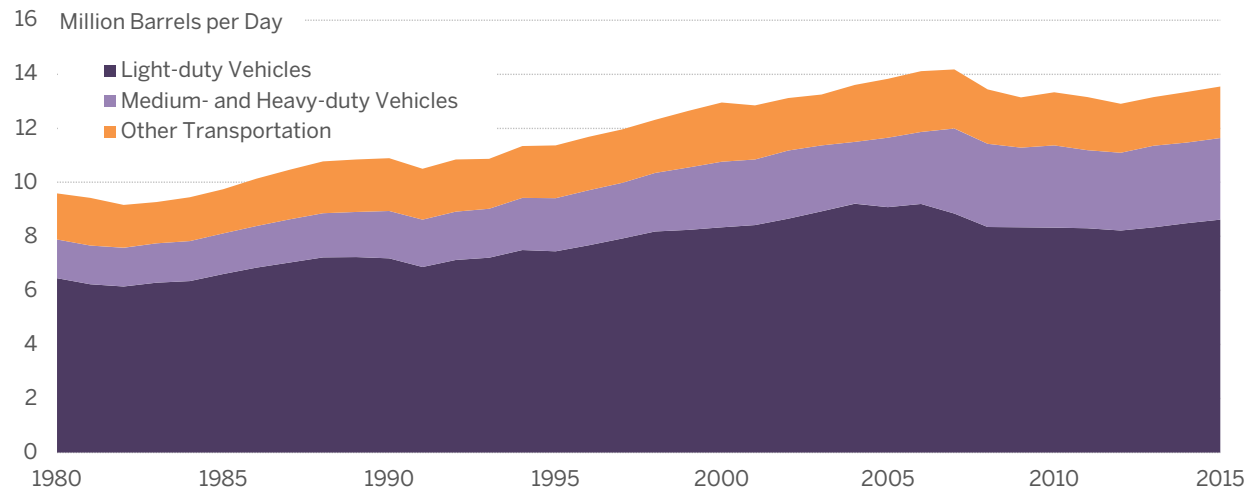
⁷ FHWA, Vehicle Weight Classes and Categories; and American Trucking Associations. "Reports, Trends & Statistics."

⁸ SAFE analysis based on data from Bureau of Transportation Statistics

⁹ Id.

In noticeable contrast to the light-duty vehicle segment, energy and oil use by medium- and heavy-duty vehicles is forecast to rise, not fall, 11 percent over the next three decades from 2.7 mbd today to approximately 3.0 mbd in 2050.¹⁰ This rise in demand is attributable to an increase in the number of medium- and heavy-duty vehicles on U.S. roads, as well as the corresponding increase in total vehicle miles driven and only gradual improvements in vehicle fuel economy. Figure 3 depicts how oil demand from medium- and heavy-duty vehicles has grown in comparison to light-duty and other sources of demand since 1980.

FIGURE 3 · U.S. Transportation Oil Demand, 1980 - 2015



Note: Allocation of total 2014 and 2015 demand is estimated.

Source: SAFE analysis based on data from EIA and Oak Ridge National Laboratory

Innovation in the commercial trucking sector is imperative to accommodating growing demand on U.S. highways and minimizing fuel price shocks to this vital industry and the broader economy.¹¹ From near-term physical changes that can improve vehicle aerodynamics, to longer-term automated trucking fleets, there are a host of new technologies that promise to reduce trucking sector oil consumption. However, moving an innovative idea or technology to widespread commercial acceptance is difficult. While some new trucking technologies are likely to be adopted when original equipment manufacturers (OEMs) and fleet managers see a positive return on investment, poorly crafted regulations, ill-conceived legislation, or entrenched interests can slow or delay the adoption of new technologies. An appropriate regulatory framework will enable the trucking industry to maximize the benefits delivered by new technologies, most notably in the form of increased energy security through reduced petroleum consumption.

¹⁰ Id.

¹¹ BTS, "DOT Releases 30-Year Freight Projections," March 3, 2016.

Other Benefits of Innovation in the Trucking Sector

If allowed to flourish, new innovations in the commercial trucking sector will go a long way toward reducing our oil dependence. At the same time, the potential individual and systematic benefits of new technologies should not be ignored. SAFE believes that the innovations discussed in this brief also offer significant gains to highway safety and congestion.

Safer Roadways

Safety in the commercial transportation sector cannot be separated from general highway safety. While vehicle accident fatalities have been decreasing steadily over the last several decades, in recent years there has been a sharp uptick. The National Safety Council reported that motor-vehicle deaths increased six percent between 2015 and 2016, with preliminary numbers showing more than 40,000 total fatalities.¹² In 2015, 3,477 people died while an additional 391,000 people were injured because of driving distractions.¹³

The commercial trucking sector is not immune to these deadly trends. Although truck drivers are not at fault in the majority of crashes involving trucks, most fatalities involving truck crashes are passenger vehicle occupants.¹⁴ Yet of the crashes caused by truck drivers, speeding, distracted driving, visibility problems, failure to yield right of way, and fatigue- or alcohol-related impairment contributed to more than a quarter of fatalities where the commercial truck driver was at fault.¹⁵ Recent innovation in driver-assist technology and driving task automation have the potential to improve safety. Safety advocates see the technologies analyzed within this policy brief as an opportunity to spark a downward trend in fatalities both in the commercial transportation sector and on the highway in general.

Alleviating Congestion

In addition to increasing on-road efficiency through advances in fuel economy, the changes and technologies within the scope of this brief present an opportunity to reduce congestion on U.S. highways. In 2015, traffic on the U.S. National Highway System cost the trucking industry \$63.4 billion in operational costs, which the American Transportation Research Institute (ATRI) estimated from the nearly 1 billion hours in lost productivity caused by commercial truck drivers sitting idly in traffic.¹⁶

Adoption of new technologies in the trucking sector hold enormous potential to reduce congestion for all Americans through a number of mechanisms. These include optimizing driving hours and routes to avoid heavily-congested areas at times of peak congestion, advanced driver assistance systems (ADAS), platooning and other vehicle-to-vehicle (V2V) enabled communication technologies that facilitate trucks occupying less road space, speed controls that help intelligently optimize traffic flows, and reduced congestion from accident avoidance.

¹² National Safety Council, "NSC Motor Vehicle Fatality Estimates," 2016.

¹³ NHTSA, "Distracted Driving."

¹⁴ Insurance Institute for Highway Safety, "Large Trucks."

¹⁵ Federal Motor Carrier Safety Administration, "Large Truck and Bus Crash Facts 2015."

¹⁶ American Transportation Research Institute, *Annual ARTI Congestion Report*, 2017.

Paving the Pathway to Full Autonomy: New Trucking Technologies

This issue brief details potential near-term innovations that could set the trucking industry on a path toward modernization and greater efficiency. Innovations include vehicle design changes, advanced driver assistance systems (ADAS), platooning and connected vehicles, and in the longer term, highly autonomous trucks. SAFE's analysis of the kinds of new technologies and innovations mentioned below found that appropriate regulatory and policy changes could facilitate saving more than 43 billion gallons of diesel by 2050, with further savings possible as the impact of autonomous vehicle technology on fuel economy is better understood.

Vehicle Design Changes

Incremental vehicle design changes may include weight reduction, improved aerodynamics, or engine efficiency. Other possibilities include replacing current size and weight restrictions with performance-based standards. Such a change would enable further design innovation and help industry match the correct heavy-duty vehicle to specific tasks. SAFE modeling estimates that improvements in freight efficiency through the adoption of linked 33-foot trailers, known as twin-33s, will result in an estimated 23 billion gallons of diesel saved by 2050.

Advanced Driver Assistance Systems (ADAS)

ADAS technologies serve to aid, warn, or assist drivers and are the foundational building blocks of autonomous truck technology.¹⁷ Examples of ADAS technologies include forward collision warning (FCW), headway monitoring and warning (HMW), lane departure warning, automatic emergency braking, and adaptive cruise control. These features can be retrofitted on trucks today and could greatly improve the safety of the overall transportation network and, if widely adopted, could reduce accident fatalities by 44 percent.¹⁸

Connectivity and Platooning

In the near future, connectivity will likely play a key role in integrating trucks into a digitized transportation system. Dedicated Short Range Communications (DSRC) can facilitate real-time communications between vehicles, and produce significant safety and efficiency gains. Platooning is a specific communication technology, enabled by DSRC, which allows two or more heavy-duty trucks to be "connected" through V2V communication. The connected trucks maintain a close, constant distance, and automatically maintain the gap between the vehicles by controlling the speed, acceleration, and braking. If widely adopted, platooning technology could save a cumulative 20 billion gallons of diesel by 2050 in the heavy-duty segment.

Highly and Fully Automated Trucks

Highly (Level 3) or fully (Levels 4-5) automated trucks would have an enormous impact on industry dynamics, potentially bringing unprecedented levels of efficiency and safety to the trucking industry. In such a landscape, transport costs for goods could be dramatically reduced and savings passed on to consumers. As OEMs and tech start-ups vie for a dominant position in the autonomous trucking space, the future of trucking presents both challenges and opportunities for the future of the freight industry.

¹⁷ Xavier Mosquet, Michelle Andersen, and Aakash Arora, *A Roadmap to Safer Driving Through Advanced Driver Assistance Systems*, Motor & Equipment Manufacturers Association & BCG, 2015.

¹⁸ Deanna Isaacs, "Trucking Industry Gets a Glimpse of its Automated Future at CES 2017," Trucks.com, January 6, 2017.

Vehicle Design

Today's typical long-haul truck averages only 6.2 miles per gallon (mpg), which may largely explain why original equipment manufacturers (OEMs) spend a considerable amount of resources on research and development (R&D) for vehicle design enhancements that reduce aerodynamic drag, improve engine efficiency, or to select the most appropriate fuel for trucks.¹⁹ Small design changes like trailer fairings or tractor-to-trailer gap reductions have the potential to reduce fuel costs by thousands of dollars each year and often have a relatively short payback period.²⁰ Other changes, such as replacing mirrors with cameras, have the potential to both improve safety and offer greater fuel savings by reducing drag, but Federal Motor Carrier Safety Administration (FMCSA) and Federal Motor Vehicle Safety Standards (FMVSS) currently prohibit the elimination of mirrors. The focus on design improvements are not just driven by OEMs, but in part by those operating or purchasing trucks for their fleets. Fleets are deeply interested in efficiency because fuel is often one of their largest operating expenses and accounts for roughly 30 percent of trucking companies' operating costs.²¹

Phase 2 fuel efficiency standards for heavy-duty trucks implemented last year by the Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration (NHTSA) are also expected to spur new innovations that will help shape the design of next-generation commercial vehicles. However, in some instances, policy barriers hinder manufacturers' ability to make progress on this front. Despite some obstacles, the deployment of new technologies and ongoing public and private R&D programs illustrate that meaningful progress is possible toward the ultimate goal of cutting oil demand over the longer term.

Increasing Freight Fuel Efficiency

Without the Phase 2 rule driving efficiency gains for heavy-duty trucks, the U.S. Department of Energy (DOE), in 2015, forecast only very gradual improvements in vehicle fuel economy. As seen in Figure 4, DOE projections before the rule was finalized anticipated average fuel economy of diesel-powered heavy-duty vehicles to grow by 16 percent over the next 25 years, increasing from 6.2 mpg to only 7.2 mpg.²² The most recent forecast, anticipating the impacts of the Phase 2 rule, revised that figure higher, to 10.3 mpg. Industry experts consider the higher level of efficiency to be both technologically and economically feasible.

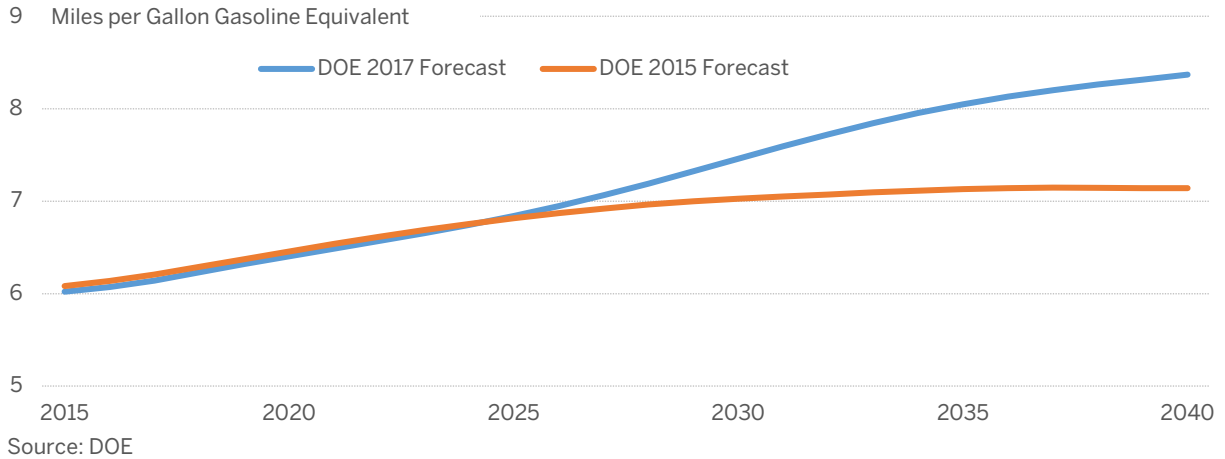
¹⁹ Brandon Schoettle, Michael Sivak, and Michael Tunnell, *A Survey Of Fuel Economy And Fuel Usage By Heavy-Duty Truck Fleets*, American Transportation Research Institute and University of Michigan, October 2016, at 6.

²⁰ North American Council for Freight Efficiency and the Carbon War Room, "Trucking Efficiency - Trailer Aerodynamics."

²¹ See, e.g., Dan Murray and W. Torrey, *An Analysis of the Operational Costs of Trucking: 2016 Update*, American Transportation Research Institute, September 2016.

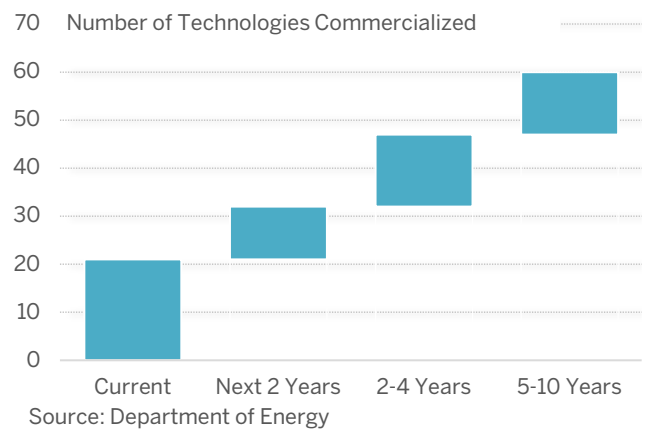
²² SAFE analysis based on data from EIA, *AEO 2015*.

FIGURE 4 · Heavy-Duty Fuel Economy (MPG)



Since 2009, DOE’s SuperTruck initiative has aimed to realize these ambitious gains, and then some. Industry participation is key to achieving the program’s goal of developing and demonstrating a 50 percent improvement in fuel efficiency for heavy-duty trucks.²³ With \$284 million in funding from DOE, four competitively-selected industry teams from Daimler, Cummins/Peterbilt, Volvo, and Navistar proved that the efficiency targets are possible within the next few years. Each team took an individualized and creative approach by focusing on weight reduction, aerodynamics, engine efficiency, or any combination of the three. While the program remains ongoing, Figure 5 shows the teams have already successfully commercialized 21 technologies, with dozens more expected in the next several years.²⁴ If all heavy-duty trucks were to utilize the technologies developed under this program, fleet operators could save thousands of dollars per year on fuel for each vehicle.²⁵ Launched in August 2016, SuperTruck II—a new five-year program with \$160 million in funding—now aims to build on the success of the program and eventually achieve a 100 percent freight efficiency improvement.²⁶

FIGURE 5 · Commercialized Tech from SuperTruck, 2016



Twin 33 ft. Trailers

The proliferation and continued growth of e-commerce has wide ranging implications for the trucking and logistics industries as they adapt to changes in freight flows and purchasing paradigms. Historically, shipments from trucks were delivered from point to point, or directly to retail stores where goods would then be available to consumers for purchase. Under this model, buyers would generally pay by the truckload for their freight needs. Today, online retailers led by Amazon employ regional distribution hubs where packages are sorted and then delivered directly to customers’ front

²³ DOE, Press Releases, “SuperTruck Leading the Way for Efficiency in Heavy-Duty, Long-Haul Vehicles,” June 27, 2016.

²⁴ Id.

²⁵ Id.

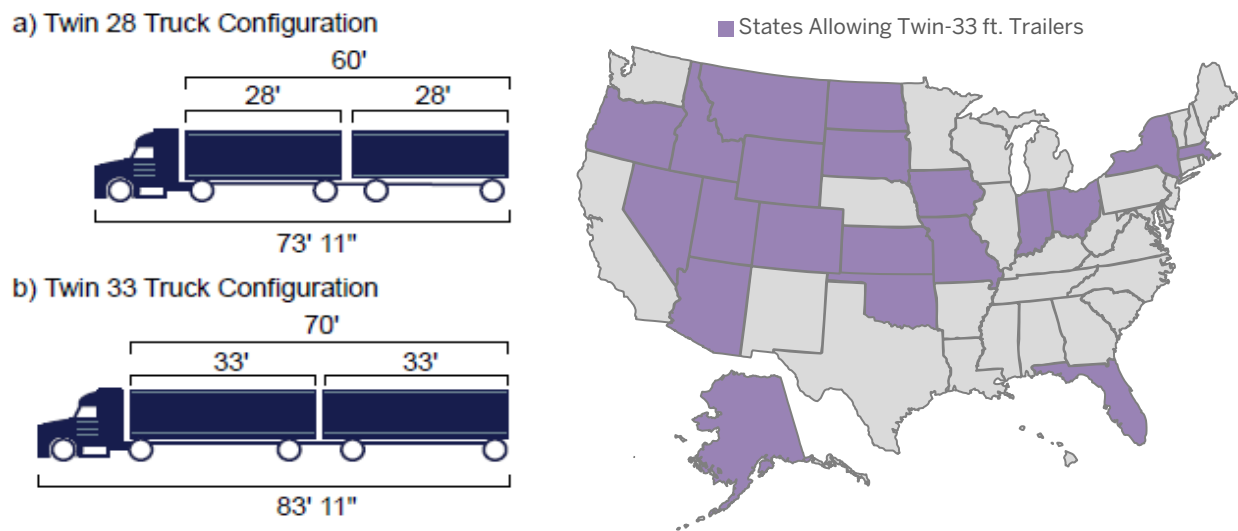
²⁶ DOE, Press Releases, “PACCAR Joins Energy Department SuperTruck II Initiative,” August 30, 2017.

doors.²⁷ These hub-and-spoke networks often utilize what is called less-than-truckload (LTL) transport, where in order to meet the expanded demand of shippers with smaller volumes (generally less than 20,000 pounds), trucks take on several LTL orders and drop them off along a specified route.²⁸

The LTL for-hire market has already reached more than \$54 billion and is the fastest growing freight mode in the trucking sector, with demand likely to increase by more than 40 percent over the course of the next decade.²⁹ Since trips normally occur on predictable routes between hubs, LTL freight is often shipped by carriers using twin trailers rather than a single 53-foot trailer. The use of twin trailers rather than single trailers facilitates quicker loading and unloading and allows drivers to drop off one of the twin trailers in a location and then continue on their journey. Currently, twin trailers are restricted in length to 28 feet each on the U.S. National Highway Network due to federal policy implemented in 1982. Many in the industry advocate that lengthening both trailers by 5 feet would improve freight efficiency without sacrificing safety standards.

Despite being restricted on federal highways, twenty states have truck length laws that allow the use of twin-33s on state sanctioned routes. Trucks hauling twin-33s have logged more than 1.5 million miles on the Florida Turnpike—the nation’s third-busiest toll road—over the past six years without any accidents.³⁰ Those in the LTL industry argue that twin-33s can move freight more effectively and safely (by reducing truck traffic), and reduce traffic congestion and fuel use, ultimately putting money back in the pockets of consumers.

FIGURE 6 · Twin Trailer Configuration and Legislative Map Showing States Allowing Twin-33 Ft. Trailers



Source: Americans for Modern Transportation

Groups such as Advocates for Highway Auto Safety have opposed longer-length trucks, arguing that they will make passing on highways more dangerous.³¹ A 2015 U.S. Department of Transportation (DOT) report found that even though trucks with twin-33 foot trailers are capable of braking within

²⁷ See, e.g., William Cassidy, “Betting on growth, LTL carriers expand terminal networks,” *The Journal of Commerce*, November 29, 2016.

²⁸ See, e.g., Freight Center, “LTL Freight Shipping,” Webpage.; and Ronald Knipling, *Twin 33 Foot Truck Trailers: Making U.S. Freight Transport Safer And More Efficient*, March 2017.

²⁹ Id.; and Boyle, “Trucking Industry Update IMUA 2016,” 2016.

³⁰ See, e.g., Retail Industry Leaders Association, “Retailers Back Plan to Allow Twin 33 Truck Trailers,” November 18, 2015.

³¹ Advocates for Highway Auto Safety, “Stop the Assault on Truck Safety.”

established stopping guidelines, trucks hauling twin-33s require 22 additional feet to arrive at a complete stop relative to other trucks on the road today.³² On the other hand, an analysis by the University of Michigan's Transportation Research Institute (UMTRI) found that twin-33s are more dynamically stable during both evasive maneuvers and at normal highway speeds.³³ Furthermore, they increase trailer volume by 18.6 percent, while the number of trucks needed to transport the same amount of cargo decreases by 15.7 percent.³⁴ A recent report by Americans for Modern Transportation—an advocacy group formed by a coalition of U.S. shippers, retailers, and deliverers—found that 4,500 fewer truck accidents would occur if legislation allowing twin-33s was passed.³⁵

Twin-33s would have a significant impact on freight efficiency, saving fuel and reducing costs. SAFE modeling, shown in Figure 7 below, estimates that improvements in freight efficiency and the adoption of twin-33s will result in 23 billion cumulative gallons of diesel saved by 2050. Excluding the potential savings from reduced wear and tear on vehicles, decreased congestion, and fewer required drivers, twin-33s could save the industry \$57 billion by 2050 on fuel costs alone.³⁶ In addition, the implementation of performance-based standards could open the door for even further savings.

Performance-Based Standards

Current U.S. government standards for trucks are prescriptive, forcing trucks to adhere to standards that are largely based on a vehicle's size (length, height, width) and weight.³⁷ Performance-based standards (PBS)—a comprehensive alternative to existing regulations that govern size and weight—considers several dimensional and component categories that include the trucks' tracking stability, group and combination axle loadings, and gradeability. Changing the scope of standards would allow for greater design flexibility, and operationalize industry's creative capacity to design and manufacture trucks specialized for their intended cargo needs.³⁸

Several countries in the Organization for Economic Co-operation and Development (OECD), including Canada and Australia, have allowed truck design to be dictated, at least in part, by PBS. Australia's National Transport Commission, for example, estimated that PBS would accrue substantial benefits, including reduced fuel use and road degradation as well as improved safety.³⁹ A study by UMTRI in 2012 demonstrated, with three different legislative scenarios, that by 2030 Australia's PBS could significantly reduce fatalities and yield up to \$5.7 billion in net nominal savings.⁴⁰ The same study evaluated the impacts of PBS in Canada, where the government used a PBS assessment to create standards for highly specialized vehicles, such as in the case of trucks pulling more than one trailer. It showed that PBS could facilitate improvements resulting in trucks being three to five times safer than standard commercial vehicles.⁴¹

³² FHWA, *Highway Safety and June 2015 Truck Crash Comparative Analysis Technical Report*, June 2015.

³³ Tom Berg, "Twin 33s Would Be Safer than 28s, U of Michigan Researcher Says," *Heavy Duty Trucking*, April 23, 2014.

³⁴ Ronald Knipling, *Twin 33 Foot Truck Trailers: Making U.S. Freight Transport Safer And More Efficient*, March 2017.

³⁵ Id.

³⁶ Note: SAFE analysis using EIA diesel prices.

³⁷ See, e.g., Phil Taylor, "Performance Based Standards a Win, Win, Win," *Prime Mover*, February 2015.

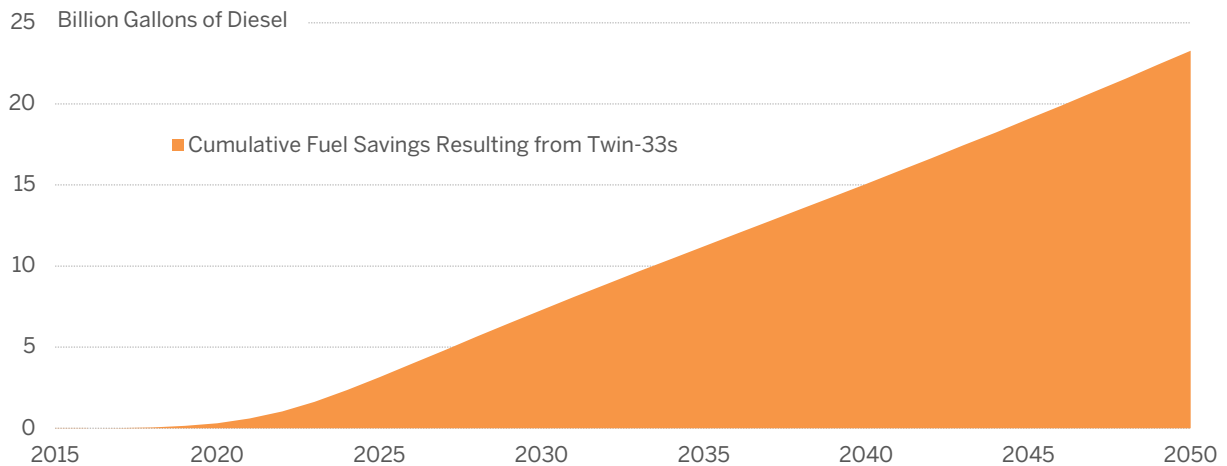
³⁸ Australia National Transport Commission, *Performance Based Standards: Regulatory Impact Statement*, March 2011.

³⁹ Id.

⁴⁰ European Automobile Manufacturers Association, *Performance-Based Standards and Indicators for Sustainable Commercial Vehicle Transport*, December 2012.

⁴¹ Id.

FIGURE 7 · Fuel Savings Resulting from Authorizing Twin-33s



Note: SAFE modeling results are based on the following assumptions. Utilization of twin-33s rises to 8 percent of heavy-duty VMT, while yielding a 3 percent loss in fuel economy and an increase in freight volume by 18.6 percent.

Source: SAFE analysis based on data from EIA

Vehicle Design: Twin-33s and Performance-Based Standards

- Unlocking potential gains in efficiency and safety in the trucking sector may require policy innovations to overcome regulatory barriers.
- SAFE modeling, shown in Figure 7, estimates that adoption of twin-33s could result in a cumulative savings of more than 23 billion gallons of diesel by 2050. The implementation of performance-based standards could lead to even greater savings.

Advanced Driver Assistance Systems (ADAS)

Vehicular safety is a primary consideration for commercial freight operators when deciding whether to invest in new truck technologies. There were more than 415,000 police-reported crashes involving large trucks in 2015, the last year comprehensive data was available.⁴² Crashes are especially expensive for companies, which experts estimate cost on average more than \$91,000 dollars.⁴³ Fatalities can increase the average cost to \$3.6 million per crash.⁴⁴

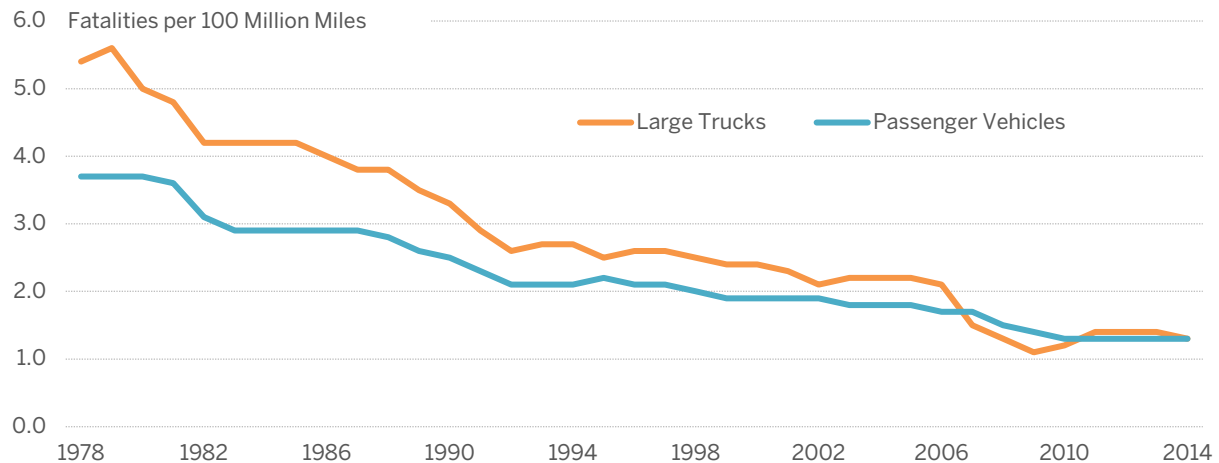
As seen in Figure 8, trucks have historically been more likely to be involved in a fatal accident than passenger vehicles. For the last decade, trucks have been as safe as or safer than light-duty vehicles on a per mile basis. However, crashes involving trucks remain both more dangerous and more costly than those involving passenger vehicles because of costs stemming from injury, loss of life, congestion, and delayed deliveries. New advanced driver assistance systems (ADAS) are poised to not only make long-haul trucks safer, but to serve as the building blocks of automation.

⁴² FMCSA, *Large Truck and Bus Crash Facts 2014*, June 28, 2017.

⁴³ William Greene, "Autonomous Freight Vehicles: They're Heeeeere!," Morgan Stanley, November 6, 2013.; and Note: Costs are in 2005 dollars.

⁴⁴ Id.

FIGURE 8 · Fatal Crashes per 100 Million Vehicle Miles



Source: FHWA

Advanced Driver Assistance Systems (ADAS) are an emerging class of safety technologies that are foundational to achieving higher levels of automation. Recognizing that ADAS technologies may enable varying degrees of automation, this section draws on the Society of Automotive Engineers' (SAE) levels of automation classification to first discuss lower-level ADAS technologies (Figure 9). The discussion will then consider how more sophisticated ADAS technologies could be integrated into the trucks of the future to enable highly autonomous functionality in trucks.

FIGURE 9 · Society of Automotive Engineers' (SAE) Levels of Automation

SAE Level	Name	Projected Incremental Cost ⁴⁵	Description
Level 0	No Automation	<\$1,000	The vehicle may possess warning systems such as forward collision warning and lane departure warning, but all aspects of driving are performed by the human driver.
Level 1	Driver Assistance	\$1,800	The vehicle may perform one aspect of dynamic driving without the driver's assistance, but the driver must perform all other tasks (e.g. automatic braking).
Level 2	Partial Automation	\$5,100	The vehicle performs multiple aspects of dynamic driving, but the driver must perform all other tasks (e.g. adaptive cruise control with lane centering).
Level 3	Conditional Automation	\$13,100	The vehicle performs all aspects of dynamic driving, but the driver must maintain situational awareness and be ready to take over driving tasks.
Level 4	High Automation	\$19,000	The vehicle performs all aspects of dynamic driving without driver input for some driving scenarios (e.g. interstate driving). However, a driver or operator may be required to be active under some driving scenarios.
Level 5	Full Automation	\$23,400	The vehicle performs all aspects of dynamic driving under all road conditions. No driver is needed.

Source: Society of Automotive Engineers & Roland Berger

⁴⁵ Note: Estimates from Roland Berger, *Automated Trucks the Next Big Disruptor in the Automotive Industry?*, April, 2016.

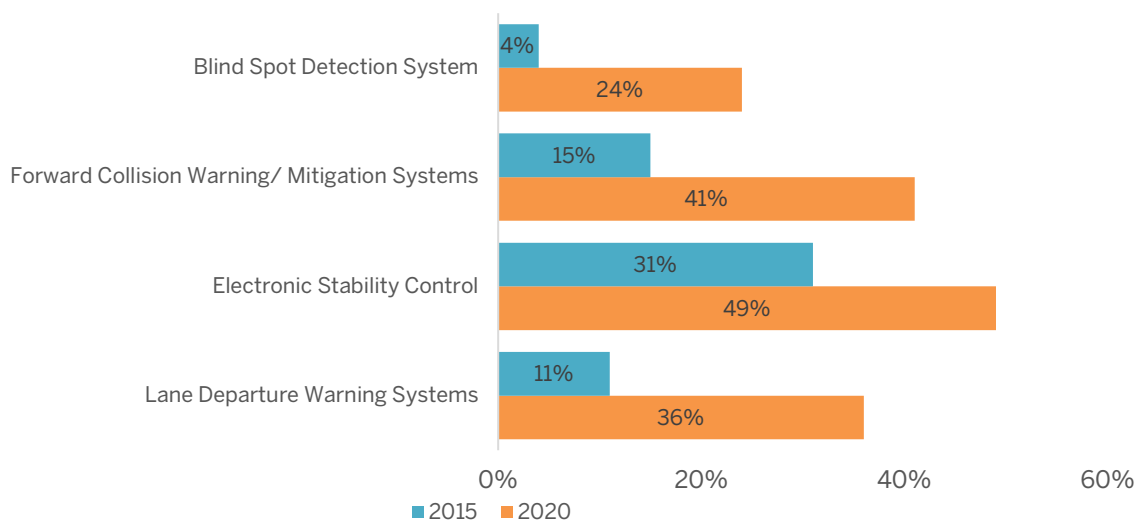
Foundational ADAS Technology for Trucks

ADAS technologies may refer to a broad suite of individual features that make driving safer and easier. Some ADAS features augment the driver's awareness of his or her environment, warning and alerting drivers of potentially dangerous situations. These technologies often include blind spot detection, lane departure warning systems, collision warning systems, and driver monitoring systems.⁴⁶ Other features, while requiring the driver to be fully engaged, are able to control simple individual processes such as acceleration and deceleration based on the distance between the truck and the vehicle in front of it. Emergency braking, adaptive cruise control, and lane keep assist, among others are examples in this category.⁴⁷

Less sophisticated ADAS technologies are already commercially available and are being made standard by many OEMs in the heavy-duty trucking space. Aftermarket solutions are also being offered by a number of firms. In addition to OEMs, Mobileye—a technology company specializing in computer vision for autonomous vehicles—offers an aftermarket system that uses visual or audible alerts to warn truck drivers of impending collisions, unsafe lane changes, dangerous following distances, or other pertinent information. The Mobileye aftermarket ADAS is a warning system that provides alerts to the driver through the use of forward collision warning, lane departure warning, headway monitoring and warning, among others. Dish Network conducted a pilot using Mobileye aftermarket warning systems and observed an 86 percent reduction in collisions and at least a 2 percent increase in fuel efficiency.⁴⁸ Aftermarket retrofits may be the easiest way to achieve widespread adoption, and to realizing the benefits such systems offer.

Figure 10, below, displays the penetration rates of relatively simple ADAS technologies in large commercial fleets, which are most capable of investing in new technologies. As costs decrease in the coming years, there will be significant potential to see rapid adoption of the technologies that offer the shortest payback period. In 2016, the average medium- and heavy-duty commercial vehicle in the United States was 14 years old, so a robust market for aftermarket installed ADAS is likely to exist for some time to come.⁴⁹

FIGURE 10 · ADAS Penetration in Large Commercial Fleets



Source: Jeff Crissey, "TECH Toolbox," Commercial Carrier Journal, vol. 174, no. 1, Jan. 2017, pp. 39-47

⁴⁶ Id.

⁴⁷ Id.

⁴⁸ Dish Network Data from Pilot Program; and SAFE interviews with industry.

⁴⁹ Fleet Owner Staff, "Class 8 Registrations Declined During the First 8 Months of 2016," Fleetowner.com, November 1, 2016.

The upfront cost of ADAS technologies may also slow adoption. Figure 9, above, depicts the incremental cost of purchasing trucks with ADAS features that enable varying degrees of autonomy. Consulting firm Roland Berger estimates an incremental cost of more than \$13,000 per vehicle to enable Level 3 automation.⁵⁰ Considering that the average long-haul truck costs at least \$100,000, this is a substantial investment that may prove initially prohibitive for some fleets, despite the returns they may see from safety improvements.⁵¹ Nonetheless, it is important to note that ADAS products are available today for under \$1,000 that prevent collisions and save lives and fuel.

In 2009, the Federal Motor Carrier Safety Administration (FMCSA) conducted a cost-benefit analysis for a number of ADAS features. These included Forward Collision Warning Systems (FCWS), Lane Departure Warning Systems (LDWS), and Roll Stability Control Systems (RSCS) and found that LDWS and RSCS, while costing several hundred dollars each to install, could save up to \$1.66 and \$9.36 respectively for each dollar spent.⁵² The FMCSA analysis showed that even under the least optimistic scenario FCWS, LDWS, and RSCS would all see a return on investment within 37 months of the initial investment.⁵³ Upfront costs have decreased in the intervening years, making these increasingly attractive outlays, and OEMs are now investing heavily to integrate ADAS technologies in the near term.

Many fleet operators are also beginning to purchase ADAS technologies on new truck models. The current global ADAS market, which includes passenger vehicles, was valued at \$23 billion in 2015 and is projected to reach more than \$78 billion by 2020.⁵⁴ While much of the growth is expected to be driven by adoption in the light-duty vehicle segment, FMCSA is collaborating with the trucking industry to gather information and data in order to eventually test and evaluate systems for commercial vehicles.⁵⁵

ADAS Enables Higher Levels of Autonomy

Today's trucks may have a few of the individual ADAS features mentioned above, but are still far from integrating all the technologies necessary to offer higher automation levels. As ADAS technologies improve to perform more complex tasks, they will likely serve as building blocks for the technology suite necessary to offer higher levels of automation. Trucks using sophisticated ADAS technologies may relieve stress on drivers and improve working conditions. Additionally, ADAS technologies have the potential to offer significant fuel economy improvements when combined with connected vehicle technology, although further study is required to validate and quantify these potential benefits.

Many of the foundational ADAS technologies provide only warnings or alerts to drivers, or automate one or two specific functions. In order to achieve higher levels of autonomy, the system must be able to control many or all driving functions competently and reliably. A Level 2 system may, for example, assist the driver in multiple functions simultaneously, such as offering both latitudinal and longitudinal control. However, drivers must always maintain situational awareness, as lower level systems are not yet sophisticated enough to handle the unexpected. A system offering Level 3 functionality, or conditional automation, can take over critical safety functions in specific environments, but drivers must still be readily available to intervene when necessary.⁵⁶ Companies like Mobileye offer some Level 2 systems for trucks, but on the whole, Level 3 systems are at least a few years away from significant commercial availability. At Level 4 and above, trucks would be

⁵⁰ Roland Berger, *Automated Trucks*, April 2016.

⁵¹ See, e.g., Sean Killcarr, "Big Rigs, Big Costs," *Fleet Owner*, November 19, 2014.

⁵² Jeffrey S. Hickman et al., *Evaluation of the Effectiveness of Onboard Safety Systems*, FMCSA, October, 2013.

⁵³ *Id.*

⁵⁴ Motor Intelligence, *Advanced Driver Assistance Systems Market - Growth, Trends, and Forecasts (2017-2022)*, April 2017.

⁵⁵ *Id.*

⁵⁶ Hope Reese, "Autonomous Driving Levels 0 to 5: Understanding the Differences," *Tech Republic*, November 2016.

capable of performing all safety-critical driving functions, and would begin to offer truck drivers and fleets even more significant advantages.

One potential barrier to mass marketization is cost. The economics of running large fleets are friendlier to large capital investments in new technologies; however, more than 90 percent of trucks on the road today are part of small fleets comprised of fewer than 20 trucks.⁵⁷ Smaller fleets do not always have the necessary resources to update vehicles with new technologies and this market dynamic could slow diffusion of some new technologies in the commercial sector. The required investment in Level 3 systems might prevent small trucking companies from making the initial investment, regardless of potential safety improvements. However, some ADAS technologies are available today for under \$1,000 that can offer smaller fleets significant benefits.

In addition to cost, there is a potential issue around end user education. OEMs and technology companies offering ADAS products have not consistently or clearly defined all the various technologies. ADAS features with similar names may have very different functionalities, which may confuse drivers. This could present serious safety concerns as the technologies become more prevalent or if drivers switch to equipment and have an imperfect understanding of the technologies enabled by various trucks. This becomes a greater concern as we shift to technologies with higher degrees of automation.

Finally, although ADAS technologies' potential is significant, their adoption and impact will unfold over a long period of time. OEMs, legislators, and other stakeholders must cooperate to create regulatory clarity that encourages economically feasible development and adoption.

Advanced Driver Assistance Systems (ADAS)

- Sophisticated ADAS could precipitate a fall in accident fatalities by 44 percent and reduce injuries by 47 percent.⁵⁸ The continued integration of ADAS in the trucking industry is an important stepping-stone to widespread adoption of autonomous truck technologies.

Connectivity and Platooning

In addition to technologies that can be adopted to make individual trucks safer or more efficient, connected vehicle technologies may open up new avenues for the freight industry to more effectively, efficiently, and safely manage entire fleets. Connected vehicles are collectively enabled by a broad range of communication technologies that “talk” to the vehicles’ surroundings—including other vehicles.

In the near future, connectivity will likely play a key role in integrating trucks into a digitized transportation system. Connected vehicle technology offers significant advantages over other on-board equipment in that the technology does not depend on “line of sight” to be effective.⁵⁹ In terms of commercial trucking, connected trucks could provide drivers advanced notice of potential hazards they cannot see, such as in construction zones or if vehicles are merging on the driver’s blind side.⁶⁰

⁵⁷ Roland Berger, *Automated Trucks*, April 2016.

⁵⁸ Deanna Isaacs, “Trucking Industry Gets a Glimpse of its Automated Future at CES 2017,” Trucks.com, January 6, 2017.

⁵⁹ NHTSA, “U.S. DOT Advances Deployment of Connected Vehicle Technology to Prevent Hundreds of Thousands of Crashes”, December 13, 2016.

⁶⁰ Id.

One NHTSA study estimated that connected vehicle technology could reduce 80 percent of all crashes where drivers are not impaired.⁶¹

While telematics has enabled the trucking and logistics sectors to become more data-driven, the ability to send and receive vast amounts of data back and forth between vehicles, infrastructure, and across the industry in real time may produce new business models. Truck platooning—one particular application enabled by connected vehicle technology—is close to commercial deployment and offers the potential for significant fuel savings. Although connectivity is not a necessity for automation, widespread deployment could augment the safety measures provided by ADAS technologies.

Connected Vehicle Technology

Two prominent connected vehicle technology platforms are V2V and vehicle-to-infrastructure (V2I), collectively called V2X (vehicle-to-everything). V2X uses transponders installed in vehicles and infrastructure to enable communication between elements of the transportation system, preventing crashes and enabling more efficient traffic flows. Thus far, the development of these technologies, which are enabled by a wireless two-way communications technology called Dedicated Short Range Communications (DSRC), has primarily focused on safety applications, such as alerting a driver to the presence of other cars at a blind intersection.

As V2X deployment and coverage improve, connectivity may offer efficiency gains that are worthy of future study. One such initiative managed by the Advanced Research Projects Agency-Energy's (ARPA-E), a government program dedicated to funding R&D for advanced energy technologies, aims to do just that. ARPA-E's NEXTCAR project looks to fund projects that consider how ADAS and V2X technologies might improve efficiency in vehicles.⁶² ARPA-E hopes to determine how advances in V2V, V2I, and V2X capabilities may transition powertrain control from a reactive to a predictive process.⁶³ In this way, "acceleration, deceleration, grade climbing, efficient engine operation, efficient transition-operation, and regenerative braking and battery state-of charge management" in hybrid electric and battery electric vehicles could be optimized and better coordinated.⁶⁴ ARPA-E aims to achieve an increase in overall vehicle energy efficiency by 20 percent through this program.⁶⁵

There are presently few commercial deployments of V2X technology in the United States. Since two vehicles on a collision trajectory would both need to be equipped with V2V for it to be effective, V2X will be most impactful once a meaningful percentage of vehicles and infrastructure are equipped with the technology. In December 2016, NHTSA issued a proposed rule to mandate V2V technology for all new light-duty vehicles, likely by the early 2020s.⁶⁶ While commercial vehicles were not included in the most recent proposed rulemaking, a similar rule is expected to be proposed for medium-and heavy-duty vehicles in the near future.⁶⁷

One potential barrier to broad adoption of V2X technology is the critical issue of the 5.9 GHz spectrum band. V2X technology has been operating on this slice of the radio frequency spectrum since it was reserved for DSRC in 1999 by the Federal Communications Commission (FCC).⁶⁸ However, wireless providers and automakers are at odds on whether the spectrum band should be

⁶¹ Id.

⁶² ARPA-E, "NEXTCAR" June 30, 2017.

⁶³ Id.

⁶⁴ Id.

⁶⁵ Id.

⁶⁶ NHTSA, "U.S. DOT Advances Deployment of Connected Vehicle Technology to Prevent Hundreds of Thousands of Crashes", Department of Transportation. December 13, 2016.

⁶⁷ See, e.g., Sean Killcarr, "Regs Outlook: Doing 'Homework,' Getting Government 'Out of the Way,'" American Trucker, March 15, 2017.

⁶⁸ Jonathan Reiskin, "Connected-Vehicle Spectrum Fight Intensifies," Transport Topics, September 19, 2016.

opened up for sharing with unlicensed devices, such as Wi-Fi, and whether such sharing would degrade V2X performance.⁶⁹

V2V technology that utilizes the 5.9 GHz band differs from other connected vehicle technologies due to its low “latency” or ability to exchange messages with very short lag time, often several milliseconds, which is critical for safety applications.⁷⁰ V2V and sensor-based autonomy approaches are complementary and will likely be pursued in concert to improve safety and other benefits.

Truck Platooning

Truck platooning is a nascent, but promising technology that has garnered a great deal of attention within the trucking and logistics industries. Platooning utilizes ADAS technology to enable two or more heavy-duty trucks to be connected through V2V communication. In a platoon, connected trucks maintain close, constant distances, automatically adjusting the gap between vehicles by controlling speed, acceleration, and braking. As envisioned for near-term applications, drivers are still required to control for lateral movement, monitor the system, and maintain situational awareness, but the platooning software largely automates the vehicle’s acceleration and deceleration.

Successful pilot demonstrations of truck platooning systems by Peloton in the United States, and Daimler and Volvo in Europe, have those in the freight industry eager to deploy the technology in commercial fleets. While Peloton is planning to launch its product in late 2017, only ten states have explicitly approved on-road testing and trial platooning demonstrations.⁷¹ This patchwork of existing state rules and regulations complicates industry interest in fleet-wide deployment, and discourages expeditious adoption; there is currently no federal regulations that discourage the use of the technology.

Fuel savings from reduced aerodynamic drag are the motivating interest in platooning technology. As seen in Figure 11 below, in recent tests conducted by the National Renewable Energy Laboratory (NREL), the lead truck in the platoon reduced fuel use by 5.3 percent while the trailing truck saved up to 9.7 percent.⁷² Depending on the number of miles a truck is platooned, savings like these could significantly lower fleet-wide fuel costs.⁷³ It is important to note that the fuel savings numbers attained under test conditions are not likely to be realized in real-world conditions. Each fleet will have individualized circumstances and routes that will help determine the viable number of miles that trucks could participate in a platoon. A recent report by the North American Council for Freight Efficiency (NACFE) estimated that a reasonable prediction for real-world efficiency gains would be “a reduction of about a quarter of the savings.”⁷⁴ Ultimately, each vehicle’s time spent in a platoon will be different, which will largely determine how much fuel is saved in practice.

⁶⁹ Global Automakers, “Safety Benefits of Connected Vehicles.”

⁷⁰ Office of the Assistant Secretary For Research and Technology, “DSRC: The Future of Safer Driving,” Department of Transportation, July, 2017.

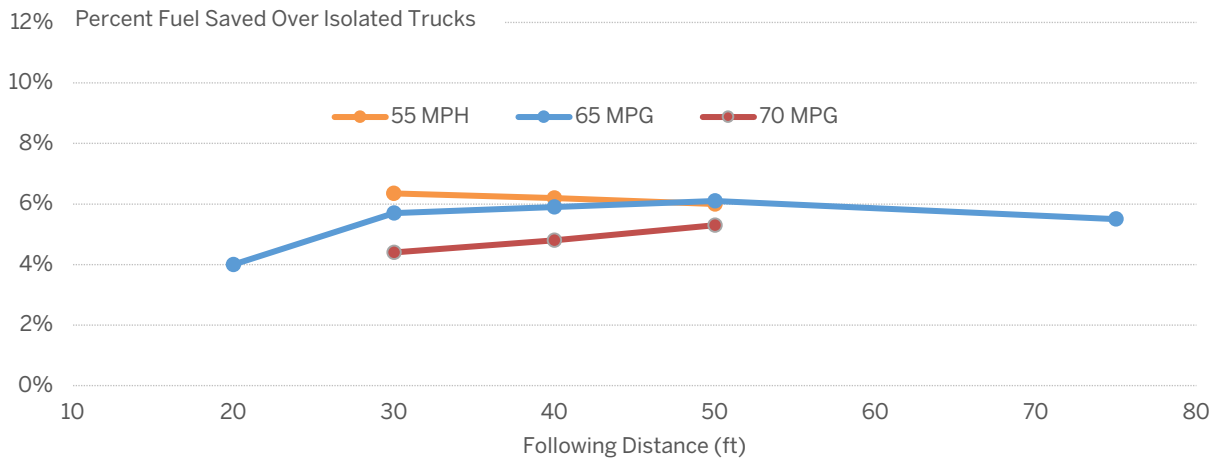
⁷¹ Nick Carey, “Peloton, Omnitracs partner on truck ‘platooning’ technology,” Reuters, February 16, 2017.

⁷² NREL, *Transportation Research*, May 22, 2015.

⁷³ Jack Roberts, Rick Mihelic, and Mike Roeth, *Confidence Report: Two-Truck Platooning*, North American Council for Freight Efficiency, September 28, 2016.

⁷⁴ Id.

FIGURE 11 · Estimated Combined Fuel Savings from Two Truck Platoon



Source: Michael Lammert, et al., "Effect of Platooning on Fuel Consumption of Class 8 Vehicles Over a Range of Speeds, Following Distances, and Mass," *SAE Int. J. Commer. Veh.*, 2014.

Platooning Background & Use Cases

Truck platooning improves the aerodynamic profile of the truck and creates fuel savings for all vehicles in the group. Both widespread ADAS and V2X functionality are prerequisites for commercial viability. Platooning is intended to be used at highway speeds, exclusively on low-congestion multi-lane divided highways and with a gap of 30 to 70 feet between trucks. In manual highway driving situations today, heavy-duty trucks follow one another at average distances of 175 feet.⁷⁵ Currently, most systems under development are only reliable during times of moderate weather, light traffic, and on well-maintained roads.

Once commercially ready, questions remain as to how often trucks would utilize the technology while on the road. Since the vast majority of trucks are part of smaller fleets, they may have difficulty in finding platooning partners. Figure 12 presents the results of a survey conducted by Roland Berger. If fleets cannot find a willing platooning partner, the potential for viable platooning miles diminish.⁷⁶ The survey showed more willingness to wait for a platooning partner in large fleets and less in small fleets.

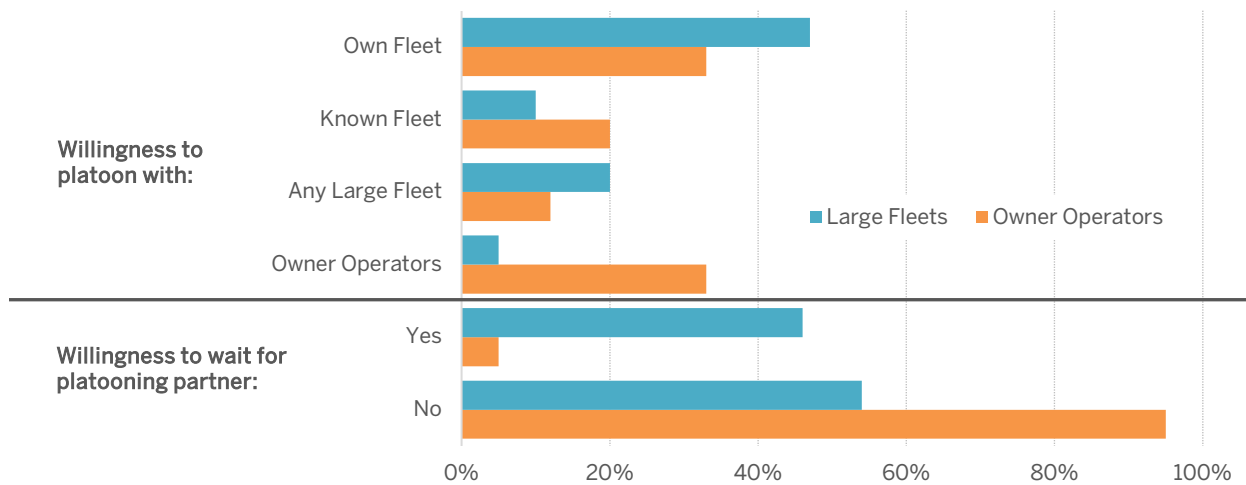
Determining who should act as the lead truck in the platoon—especially across fleets—is an important logistical question, as positioning determines the degree to which each party benefits from fuel savings. Some have suggested a new model where an entity—perhaps a third-party logistics provider (3PL)—organizes across fleets to determine an equitable way to share and distribute savings attained from platooning miles driven. Such a system, already developed by Peloton, could take the form of a cloud-based banking system that would record overall participation and allocate credits and distribute the benefits appropriately based on whether the truck served as the lead or following truck in a platoon.⁷⁷

⁷⁵ Emily Nodine, Andy Lam, Mikio Yanagisawa, and Wassim Najm, *Naturalistic Study of Truck Following Behavior*, DOT, February 2016.

⁷⁶ Roland Berger, *Truck Automation*, April 2016.

⁷⁷ Jack Roberts, Rick Mihelic, and Mike Roeth, *Confidence Report: Two-Truck Platooning*, North American Council for Freight Efficiency (NACFE), September 28, 2016.

FIGURE 12 · Finding Platooning Partners



Note: Figure 12 depicts survey data from Roland Berger where large fleets and owner operators were asked what type of operators they are willing to partner with, and if they would be willing to wait for a platooning partner.

Source: Roland Berger

Platooning Benefits & Safety Considerations

Several companies both in the United States and abroad are extensively testing platooning technology, either within the framework of a highly automated truck program or as a lower level system known as driver assistive truck platooning (DATP).⁷⁸ According to Peloton, most of the fuel savings can be captured using lower levels of automation.⁷⁹ Independent tests have demonstrated a combined seven percent fuel savings across a two-truck platoon at highway speeds with a DATP system that operates at Level 1 automation.⁸⁰ In such systems, both drivers remain fully responsible for the driving task. However, acceleration and deceleration of the rear truck is automatically synced with the front truck in order to maintain a specified following distance, or longitudinal control. Platooning at higher levels of automation could add marginal fuel savings benefits but primarily contribute to convenience for the driver. For example, by giving drivers time to fill out paperwork or use a smartphone when not fully engaged in the driving task.

In addition to fuel savings, researchers at UC Berkeley have found that low-speed platooning of commercial vehicles on urban roads could double intersection throughput, which would provide meaningful economic gains for cities and metropolitan regions.⁸¹ Dutch research group TNO also estimated two-truck platoons have the potential to decrease the amount of road space occupied by 46 percent relative to non-platooning trucks.⁸²

Like any new technology that impacts publicly shared spaces, platooning has its own proponents and opponents. Advocates of platooning technology have argued that truck platoons may improve road safety and reduce crash-related congestion because of the ADAS features embedded in the systems. However, some highway safety advocates and policymakers have been reluctant to fully embrace the technology. For example, last year, Missouri’s governor vetoed a pilot program to test platooning,

⁷⁸ See, e.g., Jack Roberts, “Truck Platooning to Become Reality This Year,” Heavy Duty Trucking, April 13, 2017.

⁷⁹ Note: Information based on SAFE interviews with industry participants.

⁸⁰ Mike Roeth, “CR England Peloton Technology Platooning test Nov 2013,” North American Council for Freight Efficiency, December 2, 2013.

⁸¹ Christopher Nowakowski and Steven Shladover, *Answering the Challenges of Regulating Automated Vehicle Testing and Development in California*, Intellimotion Vol 19, No. 1, 2014.

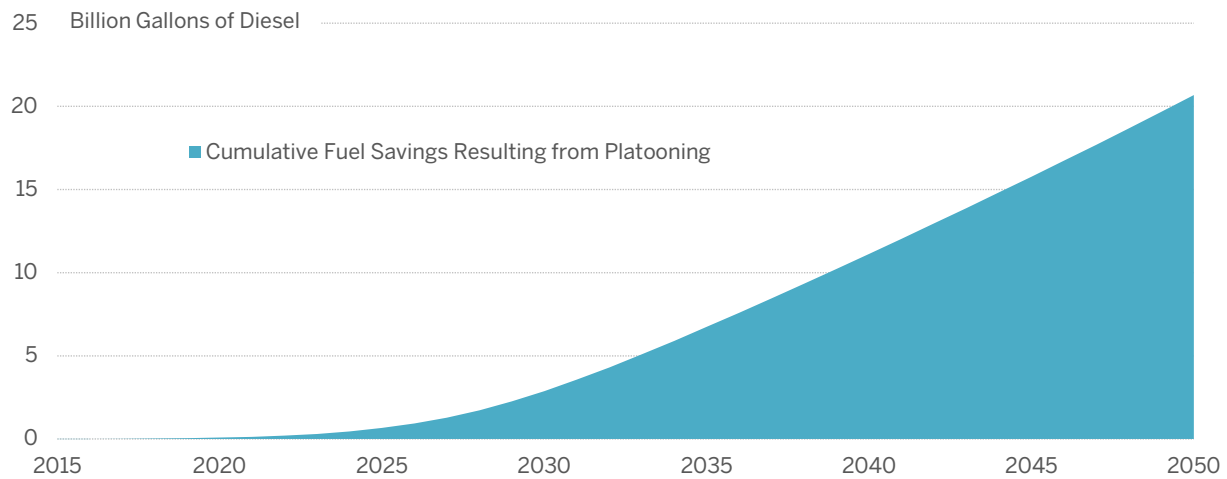
⁸² Robbert Janssen, Han Zwijnenberg, Iris Blankers, Janiek de Kruijff, *Truck Platooning: Driving the Future of Transportation*, TNO, February 2015.

noting that unproven technology is “simply not a risk worth taking.”⁸³ Others have expressed concerns about the potential danger of having passenger vehicles cut in between platoons, especially as many on-road drivers currently lack familiarity with vehicle platooning technologies.

Platooning advocates note that the foundational safety technology of radar-based active braking that enables platooning have been in the passenger vehicle market since the 1990s and can be found in roughly eight to ten percent of commercial vehicles on U.S. roads.⁸⁴ A recent study conducted by the John A. Volpe National Transportation Systems Center, a DOT-operated transportation research agency, found that a following distance of one second could prevent other vehicles from cutting in between platoons and minimize crash risk.⁸⁵

With numerous public and private sector actors investing in and studying connected vehicle and platooning technologies, commercial deployment is a near-term possibility. While further effort is ongoing to increase the performance of the systems, a supportive regulatory environment would go far to ensure adoption happens sooner, rather than later. However, many states have long-standing laws that dictate how close vehicles can follow each other.⁸⁶ Such laws may be unwittingly prohibiting platooning technology. Given the current policy focus on higher automation levels, deployment of low-level technologies, like Level 1 DATP, risk being overshadowed by legislative conversations regarding vehicle autonomy.

FIGURE 13 · Fuel Savings Resulting from Platooning



Note: SAFE modeling results are based on the following assumptions. Utilization of platooning technology rises to 50 percent of heavy-duty VMT, while yielding a 7 percent net gain in fuel efficiency.

Source: SAFE analysis based on data from EIA

Connectivity and Platooning

- Connected vehicle technology transmits data back and forth in real time, and has enormous potential for creating safer and more efficient roadways.
- SAFE modeling, shown in Figure 13, estimates that platooning technology could save more than 20 billion cumulative gallons of diesel by 2050 in the heavy-duty sector.

⁸³ Carla Grace, “This State Just Shut Down Self-Driving Semi Trucks Before They Even Got Started,” Live Trucking.com, July 13, 2016.

⁸⁴ NTSB, *The Use of Forward Collision Avoidance Systems to Prevent and Mitigate Rear-End Crashes*, May 19, 2015.

⁸⁵ DOT, Volpe, “Experts Reveal Safety Impact of Following Distances between Heavy Trucks in Automated Platoons,” May 10, 2017.

⁸⁶ See, e.g., Fleet Owner, “Report Proposes State Exemptions to Facilitate Platooning, Autonomous Tech,” August 1, 2016.

Highly and Fully Autonomous Trucks

Over the course of the last several years, the trucking industry has seen glimpses of what the future might hold. Multiple pilot programs have demonstrated that highly autonomous trucks could have real-world applications sooner rather than later. In May 2015, Daimler's Freightliner Inspiration Truck was the first licensed commercial truck to operate semi-autonomously on U.S. highways.⁸⁷ In October 2016, a truck operated by Otto, with Level 4 functionality, hauled more than 50,000 cans of Budweiser 120 miles across Colorado.⁸⁸ Although the truck was accompanied by Colorado state patrol cars, it drove the highway portion of the two-hour journey autonomously while a driver monitored the truck.⁸⁹ The feat was broadly described as the first commercial delivery by a highly autonomous truck.

Media reports often portray these high-profile demonstration projects as evidence that autonomous trucks, and the concomitant revolution in the freight sector, are imminent. Such characterizations are to some degree exaggerated and understate the regulatory developments necessary to facilitate this shift. Chris Spear, the president and chief executive officer of the American Trucking Associations, has stated that he believes autonomous trucks are decades away.⁹⁰ On the other hand, McKinsey & Company offers a more aggressive forecast, projecting that nearly one-third of all new heavy-duty trucks will be highly autonomous by 2025.⁹¹ Despite the wide range of forecasts, nearly everyone agrees that the development and eventual deployment of autonomous trucks are not only inevitable, but will bring unprecedented change to the way the freight and logistics sectors operate, with real potential for significant efficiency and safety improvements for the trucking sector.

Aligning Incentives

The trucking industry is likely to be an early adopter of autonomous technology for a number of reasons. First, much of freight transportation occurs on limited-access roadways such as the Interstate Highway System. These environments present a more predictable and less complicated driving environment than urban roads. A relatively simple driving environment reduces the technical requirements for higher degrees of automation. In addition, the industry is intensely sensitive to economic efficiencies at the vehicle level. Fleets, unlike consumers in the passenger vehicle market, make economically informed choices when it comes to fleet purchasing decisions. If lower level automated vehicles can offer a positive return on investment through fuel savings or a reduction in costs associated with accidents, fleets will quickly adopt new technologies.

The potential to leverage automation to reduce labor costs is another factor that may induce fleets to pay the additional costs required for automation. At lower stages of automation, automation can increase driver productivity and reduce strain. At higher levels of automation, drivers can accomplish other tasks and labor shortages can be mitigated through fully autonomous trucks. As seen in Figure 14 below, analysis conducted by PricewaterhouseCoopers found that fleet managers could save 28 percent on operating costs per vehicle by utilizing automated vehicle technology.⁹² Furthermore, Morgan Stanley has estimated that widespread adoption of autonomous trucks could save the entire

⁸⁷ Freightliner, "Freightliner Inspiration Truck Unveiled at Hoover Dam," May 5, 2015.

⁸⁸ Eric Newcomer and Alex Webb, "Uber Self-Driving Truck Packed With Budweiser Makes First Delivery in Colorado," Bloomberg, October 25, 2016.

⁸⁹ Matt McFarland, "A Self-Driving Truck Just Hauled 51,744 Cans of Budweiser on a Colorado Highway," CNN Money, October 25, 2016.

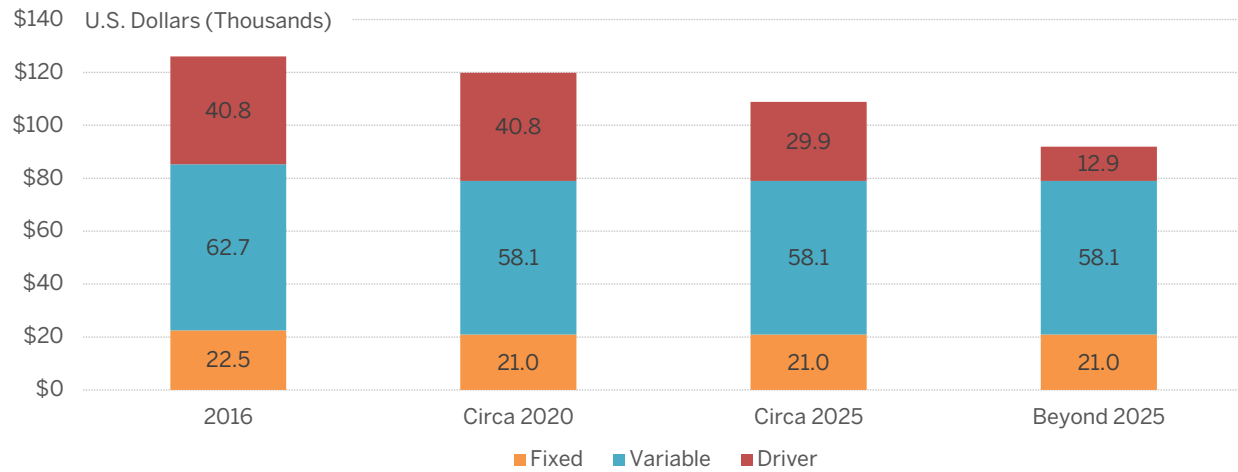
⁹⁰ See, e.g., Chris O'Brien, "One-Third of All Long Haul Trucks to be Semi-Autonomous by 2025," Trucks.com, September 12, 2016.

⁹¹ See, e.g., Fredrick Kunkle, "America's Truckers are Wary of Autonomous Rigs: 'Anything That's Run by a Computer is Going to Get Messed Up'," Chicago Tribune, May 23, 2017.

⁹² Gerhard Nowak, Jens Maluck, Christoph Stürmer, and Jan Pasemann, "The Era of Digitized Trucking: Transforming the Logistics Value Chain," PricewaterhouseCoopers (Strategy&), September 16, 2016.

freight industry \$168 billion annually, with more than \$70 billion in savings coming from reduced labor costs.⁹³ It should be noted that the degree to which technology advancement can lead to labor cost savings has considerable regulatory dependencies.

FIGURE 14 · Estimated Annual Operating Cost of a Long-Haul Truck



Source: Dr. Gerhard Nowak, Jens Maluck, Christoph Stürmer, and Jan Pasemann, "The era of digitized trucking: Transforming the logistics value chain," PricewaterhouseCoopers (Strategy&), September 16, 2016.

Labor Market Impacts

Truck drivers have served as the backbone of the freight industry for decades, and that is likely to continue for the foreseeable future. Currently, there are roughly 3.5 million truck drivers in the industry operating more than 3.6 million trucks.⁹⁴ NPR reported in 2015 found that "truck driver" was the most common job in 29 states.⁹⁵ In fact, the demand for truck drivers is so high that the freight industry has been plagued by a shortage of qualified drivers since at least 2002.⁹⁶ According to the ATA, the trucking industry is now short more than 50,000 drivers. This problem is likely to be compounded in the near future as the industry grows with the economy, and because the median age of long-haul truckers stands at 49, seven years older than the median U.S. worker.⁹⁷ As seen in Figure 15 below, ATA estimates that 890,000 new drivers will be needed to replace aging ones over the coming decade.⁹⁸

While some have publicly raised concerns that the rise of automation in trucking will lead to rapid displacement of drivers, experts consider a rapid shock to labor demand to be highly unlikely. In fact, many in the industry believe that the truck technologies discussed in this paper will serve the important role of attracting younger workers to driver and trucking support jobs. Level 3 technologies may help to alleviate the driver shortage problem, as the driving experience becomes easier and less burdensome. As the increase in productivity will be limited, and a driver will still be required in the truck at all times, only minor labor market impacts will result from level 3 automation.

⁹³ William Greene, "Autonomous Freight Vehicles: They're Heeeeere!," Morgan Stanley, November 6, 2013.

⁹⁴ American Trucking Associations, "Professional Truck Drivers and The Trucking Industry," June 2016.

⁹⁵ Quoc Trung Bui, "Map: The Most Common* Job in Every State," NPR, February 5, 2015.; and Note: The classification for "truck driver" is variable depending on occupational classifications.

⁹⁶ Bob Costello and Rod Suarez, *Truck Driver Shortage Analysis 2015*, ATA, October 2015.

⁹⁷ Id.

⁹⁸ Id.

Non-OEM Autonomous Truck Technology Developers

There are a number of new U.S. entrants racing to be the first to develop a fully autonomous truck. While all have varying approaches, many of the following companies are seeking to play a role in accelerating the deployment of autonomous trucks.

Waymo: Alphabet Inc.'s (Google) autonomous vehicle unit confirmed in June that it is working to develop autonomous trucks. While not much is known about the project or Waymo's broader ambitions in the trucking space, photos of the truck have been taken and released online.

Uber: Uber's autonomous trucking initiative (originally branded as Otto), utilizes a 64-channel spinning LiDAR model and a suite of other sensors to trial an AV system.⁹⁹ Uber is currently focused on collecting data and improving reliability for its truck. Although current operations require a driver for certain situations and for driving on local roads, Uber's long term plan is to create a fully autonomous truck. Uber is additionally focused on impacting the logistics industry through a new division called Uber Freight—a freight matching system. Uber has been testing its vehicles near its headquarters in San Francisco. Uber has faced some regulatory obstacles in its efforts in that the state of California is currently investigating Uber for unauthorized testing of an autonomous vehicle over 10,000 pounds on public roads.¹⁰⁰

Embark: Embark was co-founded by 21-year-old Alex Rodrigues earlier this year and recently has partnered with Peterbilt. Embark is utilizing LiDAR and machine learning to pilot a Level 2 autonomous truck.¹⁰¹ Embark is piloting vehicles on Nevada roads to improve their ability to conduct autonomous highway driving. The company reports that through analyzing data collected by the vehicles, it has learned how to solve glare, fog, and darkness problems. Additionally, the vehicle is now capable of passing slow vehicles on the highway and overtaking on undivided highways.¹⁰² Eventually, it plans to create a system where drivers take over the trucks at staging areas outside of cities and become increasingly responsible for the service and customer facing side of the trucking business.¹⁰³

Starsky Robotics: Starsky, another recent startup, has a radically different vision than its competition. The company envisions a future where qualified drivers can monitor "10 to 30 (highly autonomous) trucks at a time" from the comfort of a command center.¹⁰⁴ The company demonstrated their model in 2017 when it moved 5,000 pounds of freight 180 miles with the truck driving autonomously 85 percent of the time.¹⁰⁵ Starsky is already earning revenue by operating vehicles in Florida, with plans to spread to Michigan and Nevada in the near future.¹⁰⁶ Currently, Starsky trucks are operated by a driver and a software engineer, but they hope to transition to the remote monitoring model when their technology is proven.

Drive.ai: Drive.ai, which entered the space in August 2016, is building artificial intelligence for autonomous vehicles. The company recently attracted the talents of Andrew Ng, a former Google Brain founder and Baidu chief scientist, who believes Drive.ai's artificial intelligence and deep learning capabilities will make it a strong presence in the AV market. Drive.ai has a permit to test vehicles in California, and believes that local delivery vehicles, limited to specific geographical areas, are the best way to introduce AV technology to the commercial transport sector. Co-founder Carol Reiley commented that when it comes to commercial AVs, "the question we want to figure out is which routes are the most valuable to start automating."¹⁰⁷

⁹⁹ Andrew Hawkins, "Uber's Self-Driving Trucks Have a New, Fresh, Otto-Less Look," The Verge, July 5, 2017.

¹⁰⁰ Matt Drange, "Uber's Driverless Truck is Under Government Investigation Following Unapproved Tests," Forbes, May 26, 2017.

¹⁰¹ Business Wire, "Embark Unveils Self-Driving Truck," February 24, 2017.

¹⁰² Darrell Etherington, "Embark's Self-Driving Truck is Ready to Assist Human Drivers," Tech Crunch, February 24, 2017.

¹⁰³ Jordan Golson, "This Startup Sees the Highways Filled with Self-Driving Big Rigs," The Verge, February 24, 2017.

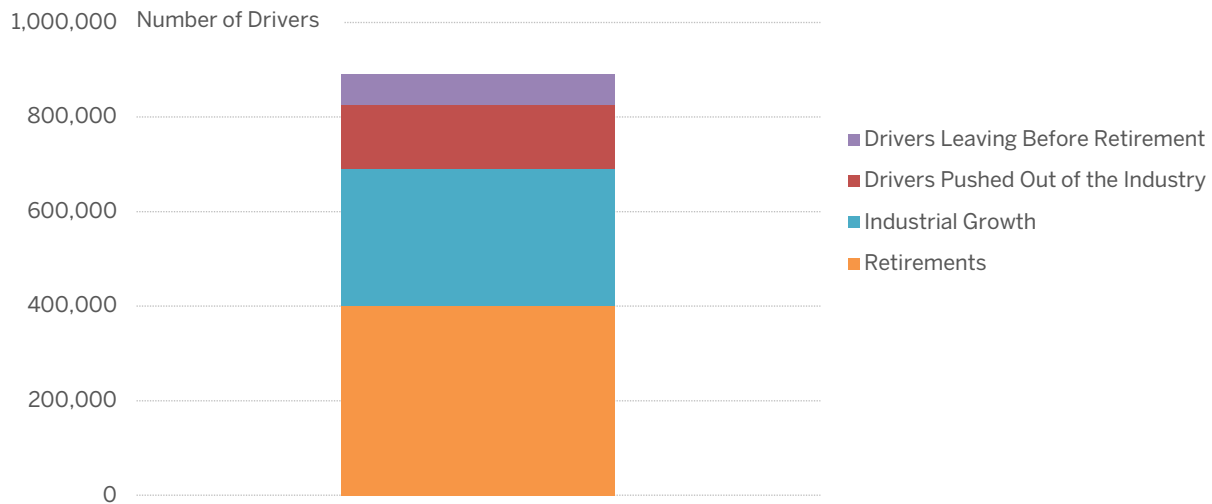
¹⁰⁴ Kirsten Korosec, "This Driverless Truck Startup is Putting Human Drivers to Work," Fortune, February 28, 2017.

¹⁰⁵ Id.

¹⁰⁶ Tim Higgins, "Self-Driving-Truck Startups Race to Take On Uber," The Wall Street Journal, March 2, 2017.

¹⁰⁷ Tim Higgins, "Self-Driving-Truck Startups Race to Take On Uber," The Wall Street Journal, March 2, 2017.

FIGURE 15 · Truck Driver Shortage by 2024



Source: Bob Costello and Rod Suarez, *Truck Driver Shortage Analysis 2015*, ATA, October 2015.

Once Level 4 functionality is achieved, the trucking industry may begin to evolve in ways that deeply impact the labor market for trucks drivers. Platooning technology, for example, may advance to a stage where one driver is able to manage an entire truck convoy. In such a scenario, a single driver may serve as the platoon lead, monitoring his system, while also maintaining responsibility for the vehicles behind him. This would allow fleets to drastically reduce labor costs, but may, in fact, be a boon to experienced drivers. Drivers provided this type of responsibility would perhaps require additional certifications or training, which could increase the value of an individual driver and enhance their earnings.

Another possibility is that highly autonomous truck technology becomes capable of eliminating the need for traditional drivers. While this is certainly a possibility, and the end goal for many technology developers, it is not likely to happen in the near future. Instead, fleets are likely to maintain drivers until the autonomous systems are developed, tested, and proven reliable. Figure 16 below shows a risk assessment of automation's impact on the truck labor market. Older, more experienced, drivers that operate mainly on short-haul routes will most likely age-out of the industry before highly autonomous technologies can be utilized in urban environments. However, younger drivers, especially those operating primarily on long-haul routes, face some headwinds as automation will become a major factor on those routes. Over time, the demand for human drivers on such routes is likely to decrease. The good news is that the labor market is weighted toward areas with the least risk. As discussed above, the driver population is older than the broader U.S. working population. Additionally, an analysis by the National Renewable Energy Laboratory (NREL) found most trucking trips are short-haul (less than 100 miles).¹⁰⁸ Shorter trips are more difficult to automate from both a technological and economic perspective and it will be further into the future before such trips will be undertaken without drivers.

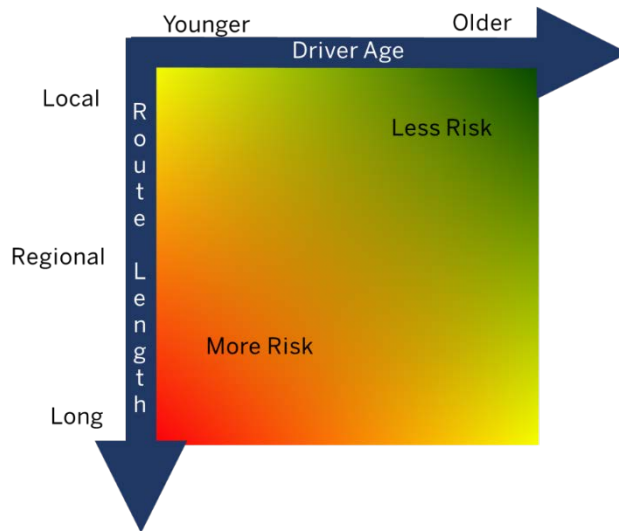
Even once technology is capable of eliminating the need for some drivers, it is likely drivers will continued to be employed to fill other essential functions. Many truck drivers do more than just drive. They are also required, as noted in a recent Brookings article, to “inspect their freight loads, fix equipment, make deliveries, and perform other non-routinized tasks.”¹⁰⁹ As the amount of freight

¹⁰⁸ Matteo Muratori *et al.*, “Potentials for Platooning in U.S. Highway Freight Transport,” NREL, March 2017

¹⁰⁹ Joseph Kane and Adie Tomer, “Automated trucking’s rapid rise overlooks the need for skilled labor,” Brookings, Tuesday, March 21, 2017.

fleets are capable of moving increases because of the rise of automation, jobs will emerge that will require the specialized skill set that only drivers have. This could include monitoring a number of trucks remotely and addressing issues as they arise.

FIGURE 16 · Risk Assessment of Automation's Impact on Truck Labor Market



Obstacles to Deployment: Public Perception

Autonomous trucks will likely be safer than human drivers as the technology matures. However, it will never be possible to completely eliminate accidents. As we have seen so far with crashes involving semi-autonomous passenger vehicles, the publicity from individual crashes can overshadow arguments based on fleet-wide safety statistics. Public opinion polls show that perception of autonomous vehicle technology is currently mixed, and it remains unclear whether the technology can survive the inevitable negative attention that will stem from early accidents.¹¹⁰ While most polling was conducted on the light-duty vehicle segment, the public may be even more skeptical of heavy-duty trucks driving on highways. In general, public skepticism and unease with autonomous trucks remains higher than for autonomous cars because of the perceived risk from large trucks, even if the trucks are safer in practice. Further understanding in this area is needed, as public opinion could quickly turn against important innovations. Throughout the cultivation and deployment of these technologies, the trucking industry will have to emphasize the dramatic roadway safety improvements these technologies promise.

Obstacles to Deployment: Regulatory Complexity

Regulation of emerging technology is always challenging, and autonomous trucks face two main obstacles. The first is that trucks are regulated by a complex network of national and state laws. The second is that autonomous trucks are governed by sophisticated computer algorithms, on-board sensors, connectivity, and supporting software. These technologies stress current regulatory frameworks, which are designed to test and approve more conventional safety technologies. Broad deployment will depend on finding new approaches to safety verification and certification. These challenges are very similar to those being faced by light-duty autonomous vehicle developers. Convening stakeholders to solve this pressing technological and regulatory problem could help advance deployment and public acceptance.

¹¹⁰ See, e.g., Brandon Schoettle, Michael Sivak, *A Survey Of Public Opinion About Autonomous And Self-Driving Vehicles In The U.S., The U.K., And Australia*, UMTRI. July 2014.

The rise of automation in trucking may require a comprehensive evaluation of existing industry regulations in areas going beyond safety assessment of new technologies. As automation increases, many extant regulations will become less relevant. For example, drivers are currently restricted to driving 11 hours each day through the “hours of service” regulation. Such a requirement is intended to provide drivers with sufficient rest to ensure they are ready, able, and focused on the driving task. Beyond simple hour restrictions, other unforeseen changes could become necessary such as driver training and other safety protocols, all of which further cloud the regulatory outlook.

Safety, Efficiency, and the Potential of Highly Autonomous Trucks

NHSTA attributes 94 percent of all crashes to human error. The vast majority of human-error related crashes were caused by recognition and decision errors (standing at 41 and 33 percent respectively).¹¹¹ Similarly, trucks have been involved in 222 truck crashes per 100 million vehicle miles traveled since 2000, and more than 90 percent of them were a result of human error.¹¹² The greatest benefit that fully autonomous vehicles offer society is undoubtedly safer roadways for both the truck drivers that take to the roads every day and for the rest of society. One study forecast that crash rates could drop as low as eight crashes per 100 million vehicle miles by 2040.¹¹³

Highly autonomous trucks also offer the potential for significant fuel savings. Although some savings may be realized at the partial automation stage, Morgan Stanley also noted that highly automated trucks could facilitate a 25 percent improvement in efficiency.¹¹⁴ A 2017 Energy Information Administration study also projected that autonomous trucks could yield fuel savings of more than 3 percent.¹¹⁵

The eventual deployment of highly and fully autonomous trucks will require years of development and testing before becoming a reality. Ultimately, though, the technical, experiential, and legislative processes are all critical pieces to ensuring this industry paradigm shift occurs in a manner that maximizes societal benefits while minimizing any potential risks.

Highly and Fully Autonomous Trucks

- The trucking industry is likely to be the first adopter of autonomous technology because freight transportation on limited-access roads presents a more predictable and less complex driving environment than urban roads. In addition, the industry is intensely sensitive to economic efficiencies at the vehicle level.
- If automated vehicles offer a positive return on investment through fuel savings or a reduction in costs associated with accidents, fleets will adopt these new technologies.

¹¹¹ Jeffrey Short and Dan Murray, *Identifying Autonomous Vehicle Technology Impacts on the Trucking Industry*, American Transportation Research Institute, November 2016.

¹¹² *Id.*

¹¹³ NHTSA. “Traffic Safety Facts.” Department of Transportation, February 2015.

¹¹⁴ *Id.*

¹¹⁵ Roland Berger, “Automated Trucks: The Next Big Disruptor in the Automotive Industry?,” presentation, Chicago/Munich, April 2016.

Recommendations

Securing America's Future Energy believes that the safe and expeditious deployment of new trucking technologies represents the best long-term solution to reduce the dangers posed by oil dependence and will make other significant contributions to the U.S. economy. Yet, widespread commercial adoption of these technologies, many of which may offer significant fuel savings, will take decades to achieve unless supportive policies are implemented. The United States will continue to rely substantially on petroleum-based transportation fuels to power its transportation system for many years to come, exposing the nation to profound economic and national security risks.

Many of the technologies mentioned above could prove transformative in helping to mitigate these risks. Forethought and planning are undoubtedly crucial to helping facilitate any transition and overcoming fears and preconceptions in the pursuit of safe, rapid, and effective adoption of the technologies mentioned in this report. SAFE offers the following policy recommendations in furtherance of these goals.

In addition, recent legislative developments and proposed autonomous vehicle regulation have been focused on the passenger vehicle segment. However, the trucking industry remains an integral part of the U.S. transportation system and should not be ignored. It is critical to ensure that an updated regulatory framework exists for the testing and deployment of highly autonomous trucks. SAFE urges policymakers and regulators to swiftly consider the recommendations included below.

Vehicle Design

Congress should transition to performance-based standards for commercial vehicles and, in the interim, authorize the use of twin 33-foot trailers.

To accommodate the growing demand for freight on U.S. highways, SAFE recommends the adoption of performance-based standards (PBS). PBS will enhance freight efficiency and significantly reduce oil consumption without negatively impacting road infrastructure or safety. While the development and agreement on a suite of safety and infrastructure criteria for PBS may take time, in the interim Congress should update a 1982 law by extending the permitted length of twin trailers—from 28 to 33 feet—with no increase to federal weight standards.

An update to the twin trailers law, perhaps accomplished through the adoption of PBS, would enable the LTL industry to save more than 23 billion gallons of diesel by 2050.¹¹⁶ Additionally, allowing twin 33-foot trailers would also produce financial savings for federal and state governments because the longer wheelbase decreases stress on transportation infrastructure.¹¹⁷ In 2015, language authorizing twin-33s to operate on U.S. interstate highways was passed by the U.S. House of Representatives and the Senate Appropriations Committee. However, this language was not enacted into law. Congress should move forward with this law, at least until a comprehensive suite of performance-based standards can be implemented.

¹¹⁶ SAFE analysis.

¹¹⁷ Woodrooffe Dynamics LLC, "Comparative Performance Evaluation of Proposed 33 ft Double Trailers Combinations with Existing 28 ft Double Trailers," April 11, 2011.

NHTSA should develop an expedited process to allow for the testing of new and innovative vehicle designs.

Technological innovation and adoption of new technologies is difficult if vehicle design changes are not permitted due to outdated regulation. It is important that the federal government provides the runway industry needs by offering truck manufacturers flexibility and protections.

Federal support may take the form of exemptions or waivers from current Federal Motor Vehicle Safety Standards (FMVSS). Many of these standards were developed years ago. The current process for obtaining waivers or exemptions is burdensome and slow, rendering it uncondusive to the development and commercialization of new technologies.

SAFE believes that an updated process should be developed that specifically addresses exemptions and waivers in an expedited manner for truck manufacturers. NHTSA should provide a response and final decision to all requests within 90 days.

Advanced Driver Assistance Systems (ADAS)

The federal government should conduct further study to quantify the fuel efficiency benefits of ADAS technologies and lead by example in promoting road safety by adopting ADAS technologies on government-owned fleets.

The safety benefits of ADAS technologies are well demonstrated and will, once widely adopted, eliminate thousands of fatalities on U.S. roads every year. Further development of more sophisticated ADAS technologies are an important intermediate step toward the deployment of highly autonomous trucks. Trucks fleets with ADAS have experienced at least 2 percent gains in fuel efficiency, but further research to validate the fuel efficiency benefits would be beneficial, especially in the heavy-duty segment. Just as fuel efficiency standards have led to more efficient engines, trailers, and other tractor-trailer components, regulators must develop ways to measure the fuel efficiency implications of advanced driver assistance features, which will incentivize fleets to invest in technologies that may have significant upfront costs.

SAFE encourages the federal government to conduct further study on the benefits of ADAS technologies in terms of fuel efficiency, and the system-wide benefits achieved through reduced congestion that are possible because of fewer accidents on U.S. roads. Once the impacts are better understood, regulators should consider providing credit for ADAS technologies in any future fuel economy standards. The government should also promote road safety through adopting these technologies on government-owned fleets.

Federal Motor Carrier Safety Administration (FMCSA), should expedite the development and implementation of its “Beyond Compliance” program, as directed by the FAST Act, providing credits to motor carriers who take concrete safety measures, including the installation of advanced safety equipment.

Connectivity & Platooning

The federal government should preserve the 5.9 GHz spectrum band for V2X communication.

V2X technology will enable fuel efficiency and safety gains, and contribute to autonomous vehicle functionality, once there is widespread deployment. The federal government should not endanger the potential benefits of this technology by allocating the necessary 5.9 GHz spectrum to other uses without first ensuring that the spectrum can be shared safely and not cause harmful interference.

SAFE recommends the Trump administration enhance the safe operation of trucks and vehicles by urging the FCC not to open the dedicated wireless spectrum for V2V and V2I unless it is conclusively proven that doing so will not compromise vehicle safety. Breaching the integrity of the spectrum has the potential to impair safety-critical applications and jeopardize their public benefits, and simply put—cost lives.

Truck platooning should be exempted from existing following distance laws.

The fuel-savings resulting from platooning increases as the distance between trucks decreases. Platooning has been tested with following distances as short as 30 feet, which results in optimal fuel savings.¹¹⁸ However, in some states, platooning technology may be prohibited because of existing “following distance” laws. The laws governing vehicle follow distances are set by states and were, in most cases, developed decades ago before platooning technology was considered feasible.

SAFE believes that as platooning technology continues to develop and is demonstrated safe, regulations should be updated to avoid impeding the deployment of this technology. There are several routes to accomplishing this goal. States should provide following distance exemptions for platooning enabled vehicles. If this approach does not succeed, and obstacles continue, Congress should consider explicitly permitting platooning on federal highways.

Highly and Fully Autonomous Trucks

The federal government should pre-empt the ability of states to set their own standards.

In September 2017, the Trump administration updated the federal automated vehicle policy that was initially released in 2016. The guidelines apply to passenger vehicles, as well as to medium- and heavy-duty vehicles. Separately, in April, FMCSA held its first listening session on highly autonomous trucks, but FMCSA has not issued guidance or regulations. The NHTSA guidance is an important step, but is not intended to serve as a complete regulatory framework. As a result, states have moved to fill the void, creating a patchwork of regulations that threaten to hinder development and allow other countries to close the gap on autonomous vehicle leadership. Concurrently, Congress is moving rapidly with broader and bipartisan legislation.

A clear framework delineating federal versus state responsibilities for AV oversight would mitigate the inconsistent patchwork of state regulations that could needlessly burden the introduction of autonomous trucks and restrict interstate commerce. SAFE strongly encourages the creation of a single, unified national framework to foster the deployment of autonomous trucks and vehicles, which is not possible without federal leadership.

The federal government should promote pilots of autonomous trucks.

The trucking industry is expected to be an early adopter of autonomous vehicle technology given the relative ease of highway versus urban automation. A handful of industry players have already conducted tests of the technology, and we encourage this to continue. SAFE recommends that Congress officially authorize pilot deployments of highly autonomous trucks along selected interstate corridors.

¹¹⁸ Michael Lammert, et al., “Effect of Platooning on Fuel Consumption of Class 8 Vehicles Over a Range of Speeds, Following Distances, and Mass,” *SAE Int. J. Commer. Veh.*, 2014.

Any pilot program would likely require designating a specific interstate highway corridor for testing, which could be accomplished by the FHWA in coordination with states and municipalities. FMCSA should participate in these pilots to better explore and understand how vehicle automation can reduce driver fatigue and lead to safer driving practices.

Collaborative

The federal government should continue to work with industry on research and development projects and facilitate collaboration among various stakeholders to advance new truck technologies. This includes the continued funding of ARPA-E, the SuperTruck Program, and other deployment-related activities.

ARPA-E supports vital research endeavors across the energy industry and has taken many promising technologies across the “valley of death” into commercialization. Its NEXT-Generation Energy Technologies for Connected and Automated On-Road Vehicles (NEXTCAR) program is now exploring how connected and automated vehicles can reduce energy consumption, which could play a critical role in the development of autonomous vehicles. Fred Smith, the founder, chairman, president, and CEO of FedEx has stated that, “pound for pound, dollar for dollar, activity for activity, it’s hard to find a more effective thing government has done than ARPA-E.”¹¹⁹

SAFE recommends that Congress continue to fund ARPA-E and other projects geared toward transformative technologies at the intersection of transportation and energy. Ensuring the continuance of ARPA-E would directly lead to a better understanding of the efficiency benefits of connectivity and semi-autonomous technologies.

The Department of Energy’s SuperTruck Program is similarly driving important innovations in the heavy-duty segment and is an example of how government and industry collaboration can drive innovation. The program combines federal and industry funds with the goal of doubling freight-hauling efficiency. Without this collaboration, the commercialization of new fuel-saving technologies may be delayed by years. Therefore, SAFE recommends the continued funding of the SuperTruck initiative, as well as other activities that lead to the deployment of new truck technologies.

¹¹⁹ Michael Lewis, “Why The Scariest Nuclear Threat May Be Coming From Inside The White House,” Vanity Fair, September 2017.

Contributors

Amitai Bin-Nun, Vice President of Autonomous Vehicles and Mobility Innovation
Jeff Gerlach, Senior Policy Analyst
Skylar Drennen, Intern

For media inquiries, please contact:

Leslie Hayward, lhayward@secureenergy.org and (202) 461-2364.

