Written Testimony of

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Commerce, Science, and Technology

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Hands Off: The Future of Self-Driving Cars

Dear Chairman Thune, Ranking Member Nelson, and distinguished members of the Committee:

Thank you for offering us the opportunity to submit this written statement to the committee on this critical topic. My name is Robbie Diamond, and I am the Founder and CEO of Securing America's Future Energy (SAFE). For over a decade, SAFE has worked to strengthen America's national and economic security by reducing our oil dependence in the transportation sector and the nation's resulting exposure to the destructive impacts of oil price volatility. In 2006, SAFE formed the Energy Security Leadership Council (ESLC), a nonpartisan group of business and former military leaders in support of long-term policy to reduce U.S. oil dependence. The ESLC is co-chaired by Frederick W. Smith, Chairman, President and CEO of FedEx, and General James T. Conway, 34th Commandant of the U.S. Marine Corps (Ret.).

SAFE's primary mission centers on ending the United States' extreme reliance on oil as a matter of national and economic security. This strategic commodity is bought and sold on an unfree global market under the influence of the Organization of the Petroleum Exporting Countries (OPEC), its member nations and other national oil companies (NOCs), which control over 90 percent of the globe's proven crude reserves. Activity by the cartel over the past year and a half shows its ability to move the market to meet the political aims of its most powerful members.

Solving the challenge of oil dependence will require the sum of America's ingenuity on both the supply and demand side of the transportation equation.

SAFE believes that autonomous transportation could bring about the most dramatic transformation in society in the last 100 years. Combined with vehicle electrification, this shift could deliver unprecedented benefits by unleashing trillions of previously non-productive hours, addressing the dramatic underutilization inherent to the current vehicle ownership model, significantly curbing the more than one million traffic fatalities annually worldwide, providing mobility and freedom to the disabled and elderly, and securing dramatic reductions in oil demand through efficiency and fuel diversification. In several critical respects, electrification and autonomy promise to strengthen and accelerate the adoption of both technologies.

Despite a growing consensus that AV technology is on track to fulfilling its promise, we are nevertheless concerned that poorly crafted regulations, ill-conceived legislation, or entrenched interests could derail the manifold benefits AVs will bring.

We strongly advocate for a regulatory framework that maximizes the benefits delivered by AVs for energy security and beyond, including the potential for greatly increased mobility for America's most vulnerable populations and a dramatic reduction in traffic fatalities. As such, we are actively engaged in efforts to design and build stakeholder support for policies ensuring that AV innovation and consumer adoption do not fall victim to unnecessary regulatory and legal obstacles.

To this end, last year, SAFE formed an Autonomous Vehicle Task Force to advise us on the transformation currently underway in the transportation sector. The Task Force is composed of leading business, technology, and policy experts in the autonomous vehicle space.

Based on the research activity of our staff, broader experts in vehicle automation, and many of our ESLC members, we offer you some key perspectives on the benefits offered by autonomous vehicles, the current and likely future state of technological deployment, as well as a set of policy recommendations developed by our team.

Energy Security and the Autonomous Vehicle Opportunity

The U.S. transportation sector relies on oil for 92 percent of its total energy consumption, rendering the U.S. economy vulnerable to oil price volatility. These violent oscillations, hitting their highest levels since the 2008-2009 financial crisis at the end of 2015, inject uncertainty into the broader market and make it difficult for consumers and businesses to plan and invest for the future. Every U.S. recession during the past 40 years has been preceded by, or coincided with, an oil price spike. Between 1970 and 2013, oil dependence is estimated to have cost the U.S. economy almost $7 trillion.

Even though current oil prices are relatively low due to an oversupplied market, more than 3 percent of U.S. gross domestic product was spent on oil in 2015. And while the shale oil boom has been beneficial (and should be encouraged), improving our balance of trade and reducing our reliance on imports, the United States still sent nearly $1 billion abroad each day to pay for oil in 2014.

The extreme economic importance of oil also creates adverse national security challenges and undermines the United States' ability to conduct effective foreign policy. Notably, more than 50 percent of the world's daily oil supplies transit through seven major chokepoints in often unstable regions, particularly the Middle East. The U.S. military is forced to accept the burden of protecting these maritime supply routes and vulnerable energy infrastructure across the globe at a cost of between $67.5 billion and $83 billion annually, according to a RAND Corporation study.

The global oil market is also frequently subject to unpredictable—and sometimes anti-competitive—behavior from oil-producing countries that supply it, most notably from members of OPEC. For example, OPEC's November 2014 decision not to reduce output despite historical actions to the contrary helped contribute to a more than 50 percent decline in oil prices between the summer of 2014 and January 2015. Many believe Saudi Arabia, OPEC's de facto leader, has pushed to maintain OPEC output expressly to damage the U.S. shale industry—as well as harm its geopolitical foes.

Because the United States has very limited control over oil price volatility and the foreign actors responsible for most of global production, the widespread use of vehicles not dependent exclusively on petroleum represents the best long-term solution to U.S. oil dependence. Yet plug-in electric and other advanced fuel vehicles (AFVs) have thus far achieved only a small share of total vehicle sales.

SAFE believes that autonomous vehicles will likely accelerate and drive the adoption of EVs, rather than the inverse. EVs today offer a consumer proposition very similar to an internal combustion engine (ICE) vehicle, which has been the same for more than 100 years: getting from "point A" to "point B." The leap from a "standard" vehicle to an autonomous one is arguably on

par or greater than the jump from traditional cell phones to today's ubiquitous smartphones. Once proven safe, consumers will likely quickly adopt this technology that promises more time with no driving, no congestion, no parking, and no refueling. An autonomous vehicle, as opposed to an EV, offers a totally different consumer proposition. As such, rather than needing encouragement through government action, we expect consumer choice will drive rapid adoption of AVs and result in significant energy security benefits (through fuel diversification) as well as myriad social benefits.

Current Status of Technology

Background: While it has long been possible to automate some of a vehicle's functions (e.g. cruise control), the last few years have seen an increasing focus on the potential to deploy highly automated vehicles to the public. Relatively new entrants to this space have been particularly influential. Google began its AV work in 2009, and as of January 2016, the company has tested more than 1.4 million autonomous miles on public roads. Tesla Motors has rolled out a suite of automated features known as Autopilot, which allows for current users of Tesla vehicles to almost completely automate highway driving in the right conditions.

Automotive companies have not ignored this important trend. By now, most have announced autonomous vehicle development activities, although companies differ in whether they are aiming for "full automation" where the driver is rendered unnecessary, or using autonomous vehicles as a "backup driver" to improve safety. Some automakers are experimenting with new business models such as carsharing and other mobility on-demand services, while others believe that personal vehicle ownership will remain the near-exclusive paradigm for most Americans for decades to come. There has been an increase in merger and acquisition activity, such as General Motors' recently announced acquisition of Cruise Automation.

Potential Deployment Trajectories: The traditional trajectory for new technology adoption in the light-duty vehicle market has been the gradual deployment of features in upmarket products, which slowly diffuse downmarket until ubiquitous. The product cycle in the automotive industry is 5-7 years. Together, these trends usually mean that new technologies take several decades to diffuse across the entire fleet.

One potential deployment trajectory for autonomous vehicles is iterative. The current generation of vehicles has significant uptake of automated features such as Automatic Emergency Braking, Adaptive Cruise Control, and Lane Keeping Assist. The next generation will have more advanced autonomous features, and, in a number of generations, full autonomy would be possible. There are a number of notable outcomes in this trajectory. One, it will take a significant amount of time, given the current time it takes to iterate a single technology across the fleet. Secondly, during the development of this technology, cars will continue to require drivers at all times, as their autonomous functions will not be robust enough to eliminate the driver. Consequently, private household ownership of vehicles will remain the dominant paradigm for generations to come. This is the **"Iterative Autonomy"** deployment paradigm.

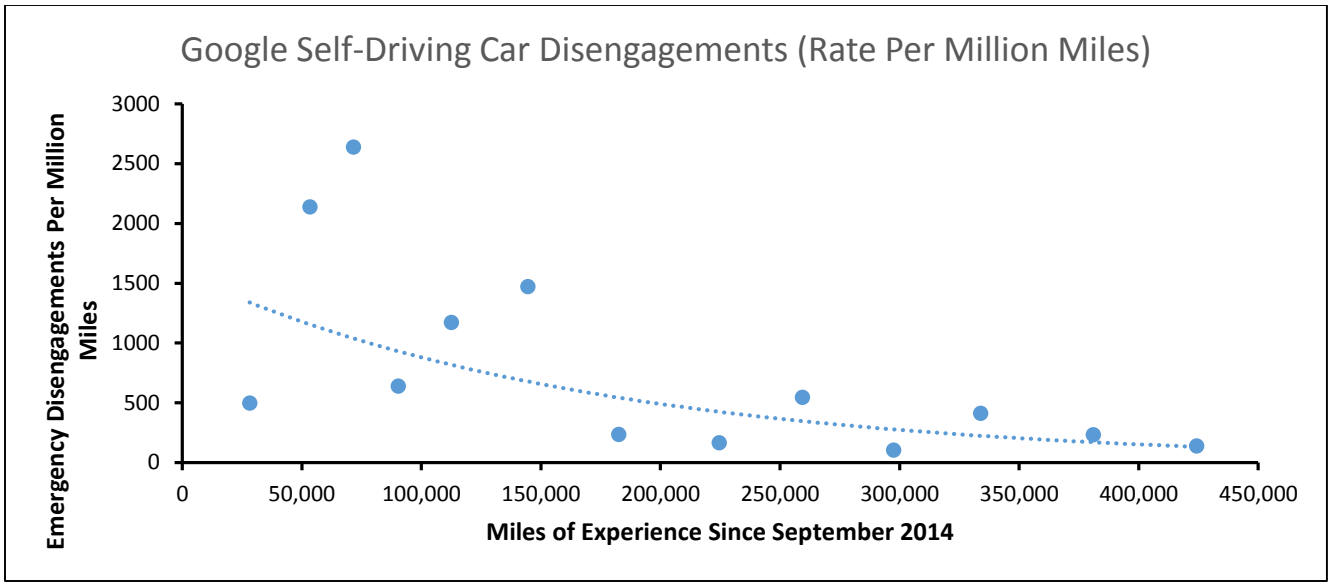
A different trajectory represents a new approach to new vehicle technology deployment. It may not be feasible in the near future to deploy fully autonomous vehicles on all roads and in all

conditions. This does not mean that the vehicles should not be deployed at all. Instead, we should see deployment of fully autonomous vehicles in limited areas and with limited functionality, such as lower maximum speeds. A likely initial deployment would be in areas such as private developments, restricted-access highways or, more ambitiously, a low-speed urban core. As the technology improves, more and more areas will be made accessible to AVs. Eventually, autonomous vehicles will be able to navigate just about any road at any time at any lawful speed. This is the **"Autonomous First"** deployment paradigm.

Both of these approaches offer social benefits, and the market will decide how quickly we will progress to fully autonomous vehicles. However, the "Autonomous First" pathway, being pursued by some technology companies and OEMs, offers a quicker route to the benefits of AVs. It is a more difficult pathway, however, from a legal and regulatory perspective. A broad range of national, state and local level regulations would need to be altered or streamlined to allow for this deployment trajectory.

The development of AVs is not limited to light-duty applications. The freight industry is likely to be an important early adopter of autonomous vehicle technology. The movement of goods often involves long stretches of highway driving, which is considerably easier to automate than urban driving, with much of the necessary technology already available. Additionally, perennial driver shortages and resulting costs will incentivize fleet owners to adopt autonomous technology once it becomes economically rational to do so. This must be encouraged, and a regulatory pathway must be opened and kept open.

Safety: There is strong evidence that AVs are rapidly becoming more advanced and may already represent an improvement over human drivers in certain situations. Companies testing on public roads in California have released data on how many miles they have driven in autonomous mode and how often "emergency disengagements" have happened, when either the car's computer system hands control over to the test driver, or the test driver decides to take over for safety-related reasons. Several companies have submitted reports, and we analyzed Google's disengagements over time, as their sample size is the most robust.



As can be seen in the graph, the number of emergency disengagements decreased exponentially as the Google team gained experience. Over the 14-month sample, the rate of emergency disengagements was cut in half for every 100,000 miles of experience, or 2-3 months at Google's current pace of testing.

Key Benefits of Autonomous Vehicle Technology

Energy Security: Studies, including our own internal modeling, demonstrate that AVs can reduce oil dependence. A recent analysis of AV technology, partially conducted by the Oak Ridge National Laboratory, shows numerous opportunities for reduced energy consumption. These effects include:

- Mitigation of congestion through improved traffic flow and reduced accident frequency.
- Smoother braking/acceleration and other driving maneuvers leading to reduced energy consumption.
- Vehicles will be allowed to safely follow one another at short distances, resulting in fuel efficiencies.
- In the long term, as vehicles become safer, the weight of the vehicle could safely decrease, increasing fuel efficiency.
- As humans spend less time in control of the driving experience, consumers may be more likely to purchase cars that are optimized for fuel efficiency and cheaper operation, rather than performance characteristics.

Critically and as referenced above, AVs also could accelerate the consumer adoption of electric vehicles, one of the most effective means of improving U.S. energy security. Electric vehicles are fueled by diverse, domestic fuels and the price of electricity historically has been very stable. This argument goes beyond the comparative efficiency of electricity and oil as fuels and speaks

to the value of diversification and freeing a sector that has remained hostage to the global, volatile oil price.

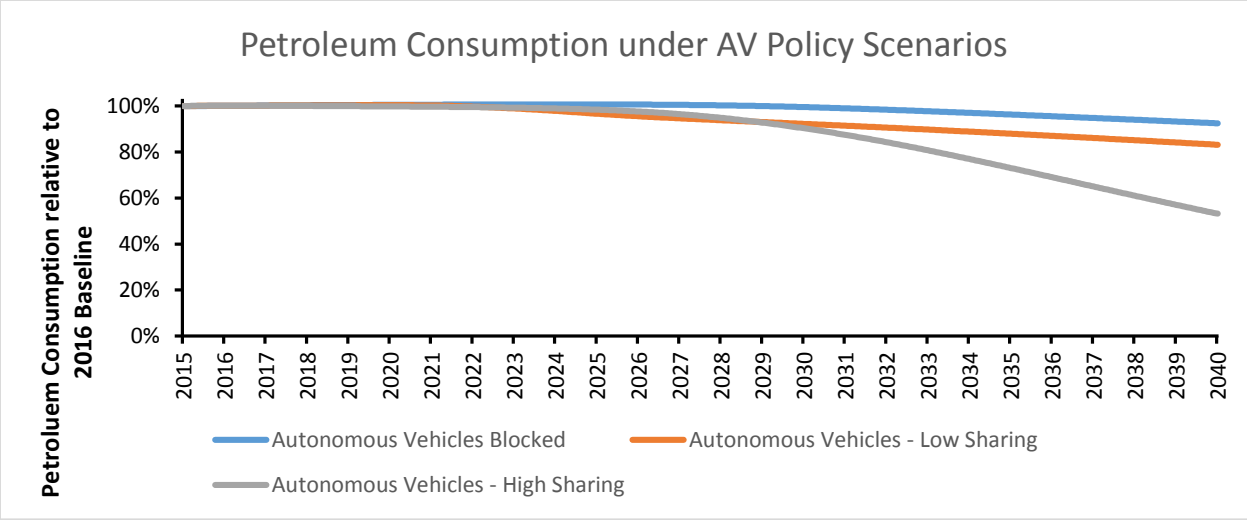
This transition will happen because autonomous vehicles, even if privately owned and not shared, will likely travel more miles than the current generation of cars, which tips the economics of a car-purchasing decision to a higher capital cost, lower operating cost model that favors AFVs such as electric, fuel cell, or natural gas powered cars.

In addition, mass AV adoption has the potential to increase vehicle miles traveled (VMT), as cost per mile traveled is reduced and underserved groups (older Americans, Americans with disabilities, children) begin moving more. This should not be seen as a negative outcome if those miles are traveled by AFVs and not petroleum-powered vehicles, on which we are overly reliant.

A future which includes significant AV carsharing would be a boon to the adoption of advanced fuel vehicles and accrue significant energy security benefits. While many consumers will continue to own personal vehicles, our modeling indicates that the economics will strongly favor the adoption of advanced fuel, shared, autonomous cars. While 90 percent of car trips in the United States have 1 or 2 passengers, most domestic market light-duty vehicles can accommodate 5 or more passengers. The light duty fleet is incredibly underutilized, because households do not purchase a vehicle based on their average trip, but for the times they need to carpool or carry sporting equipment on a vacation. On average, vehicles are only in use for about 4 percent of their lifetime, or about one hour per day.

If the market supports the emergence of large fleets of shared cars, this could potentially have three major impacts: 1) The fleet can be "rightsized," allowing for cars that better meet the needs of consumers for their current task; 2) car companies will be able to rightsize batteries based on different range requirements (cars that go 30, 60, 100, 200, or 300 miles), driving down the cost of batteries needed in an electric vehicle; and 3) cars can be lighter, as safer autonomous driving enables vehicle "lightweighting," allowing cars to go farther on the same-sized battery.

Our simulations show that, if the autonomous future includes significant carsharing, petroleum usage in the transportation sector could decline by 50 percent by 2040, or perhaps even faster given the right mix of technology and regulatory developments. This is an opportunity that must be acted upon without delay. That said, SAFE believes that consumers will have the option of retaining a personal vehicle for convenience and easy access or ordering a customized vehicle to meet their needs at a given time.



But SAFE considers policies that promote fuel diversity and efficiency in the transportation sector only one side of the energy security equation—the importance of domestic oil production cannot be understated, especially as global oil demand is expected to continue growing. Autonomous vehicles powered by advanced fuels would enable the United States to limit its own oil consumption while increasing production to accommodate world demand growth, offering the ideal combination for the country's energy security.

Safety: Even as effective advanced safety technologies become more prevalent and reliable, motor vehicle-related fatalities rose 8 percent in 2015 to 38,300. The total estimated cost of vehicle crashes exceeds $800 billion per year. AVs will prevent most, perhaps even the overwhelming majority, of the 93 percent of crashes caused by human error.

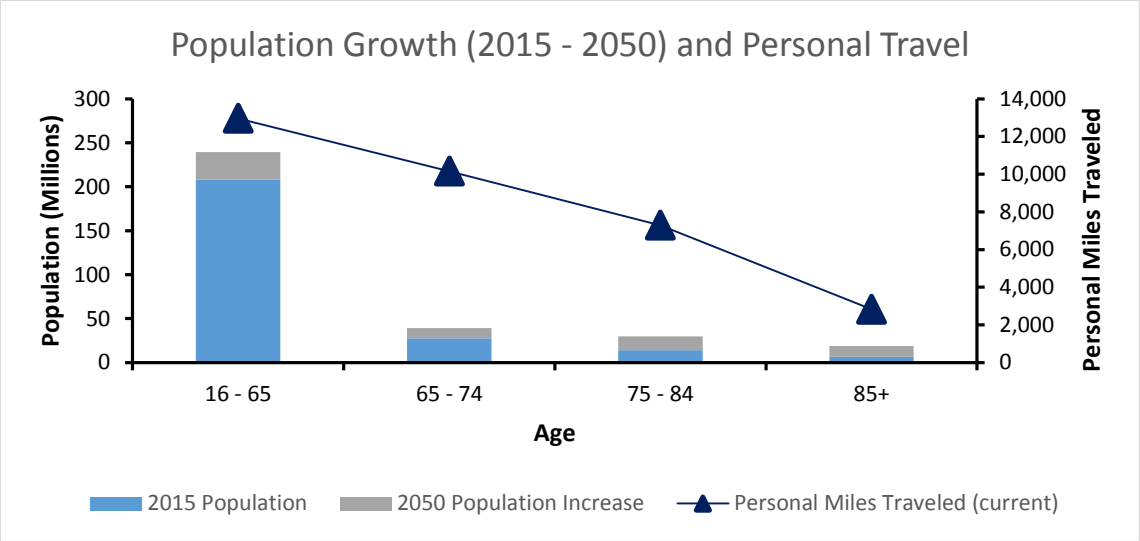
Minimal vehicle automation, in the form of cruise control, automatic emergency braking, and lane keep assist, already has demonstrated effectiveness in reducing accidents, property damage, and most importantly, saving lives.

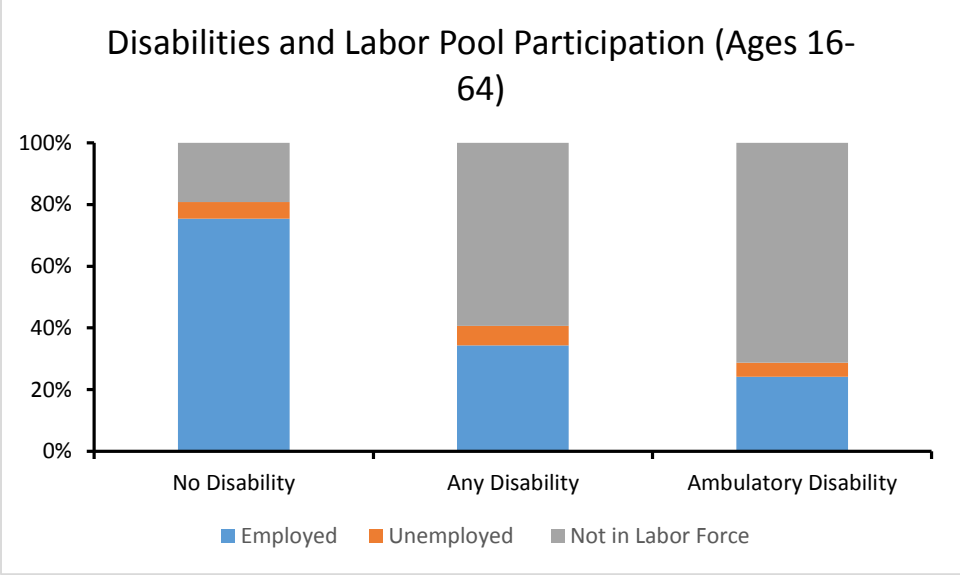
However, there is reason to believe that medium levels of autonomy, where the driver can fully hand over operations of the vehicle for a period of time, may prove to be less safe than full autonomy, as humans will have difficultly reengaging when necessary after periods of inactivity. From a public policy point of view, the opportunity to save more than 100 fatalities occurring on U.S. roads **every day** should not be delayed. Insofar that this is a debate about safety, we must measure the lifesaving potential of autonomous vehicles against the reality of the level of fatalities and injuries happening on our roads today. Blocking AVs on the basis of safety would be an illustration of "the perfect being an enemy of something very good."

Mobility Access: By 2050, the number of Americans older than 65 will approach 90 million, more than double today's number. Studies show that as Americans enter their 70s and 80s, they sharply reduce travel largely due to age-related factors. Autonomous vehicles can provide mobility and dignity to older Americans, better integrating seniors into society and contributing significantly to economic growth by keeping them active and economically engaged in their

communities. In addition, the potential to reduce healthcare costs by providing elderly Americans greater access to doctors and clinics using AVs—before they have to visit emergency rooms for acute care—should be studied.

Similarly, the disabilities community could be transformed through better access to mobility. According to the U.S. Census Bureau, the labor force participation rate for individuals with an ambulatory disability is only 25 percent, compared to 75 percent for the broader population.





Finally, access to efficient, quick, and reliable transportation significantly improves the odds for individuals seeking to escape poverty. AVs will increase economic mobility and help lower-income Americans access better employment. Too often, low-cost mass transit options fail to address this challenge, as they are limited by the size and scope of their infrastructure.

Policy Recommendations

AVs may need to be addressed at the federal level: The Interstate Highway System allows fluid travel across and between states precisely because it is a national network. Similarly, recent efforts by California and other states have demonstrated that AV regulation may need to be primarily a federal effort if the technology is to succeed. Just as skipping over a state in its path would make an interstate highway impossible, a patchwork of different state regulations have the potential to stymie the deployment of AVs. SAFE is actively considering this challenge and available policy choices. SAFE and its Energy Security Leadership Council plan on releasing specific recommendations on May 19, 2016.

AVs should be allowed when as safe as a human driver: Governments should allow the deployment of fully autonomous cars as long as they are as safe as a human driver. While computer "drivers" will be far less error-prone than their human counterparts, we cannot allow the perfect to be the enemy of the good and continue to put at risk more human lives than necessary by demanding an unreasonable level of perfection.

Regulations must be changed to remove roadblocks to AV deployment: The "Autonomous First" framework is one natural path for AV deployment. However, there are numerous legal and regulatory roadblocks that are holdovers from an age before AVs were anticipated. These range from the international Vienna Convention, to national level codes dictating vehicle design, to local municipal regulations on "for-hire" vehicles. These all present different types of regulatory obstacles to AVs, and action may be needed in Congress and federal agencies—in coordination with states and municipalities—to remove these expeditiously.

Test deployments as soon as feasible: Given just how discontinuous AV technology is compared to what has come before, real experience is important, not just for technology developers, but for regulators as well. Before full regulations are developed, the federal government should encourage companies to test AVs in several locations and with a variety of use cases. Federal and local governments should collaborate with the private sector to select these sites and use lessons from these test deployments to develop regulations as necessary.

Energy security and other social benefits: Market-based mechanisms should encourage the use of autonomous vehicles to achieve social benefits such as increased mobility for older Americans, Americans with disabilities, and lower-income Americans. The energy security benefits of autonomous vehicles should be maximized by encouraging the deployment of advanced fuel vehicles.

Additionally, AV deployment should not be limited to light-duty vehicles, as considerable energy security gains are attainable through the automation of heavy-duty trucks and the freight industry.

Government should do no harm: The government's role should be limited at present to ensuring that policies do not impede innovation and adoption. Some government activity and modest spending will be required to create a regulatory framework. The private sector is capable of investing in development of the technology, and there are strong incentives for it to continue to do so.

Conclusion

U.S. transportation is poised to undergo the greatest transformation since the invention of the automobile over a century ago. Autonomous vehicles stand to not only drastically improve America's energy security through fuel diversity while virtually eliminating automobile accidents, but offer equally compelling cases in favor of giving mobility to millions of otherwise home-bound Americans and allowing them increased participation in society and the economy. But these benefits will only be realized if policy makers grant autonomous technologies a wide enough berth to fully explore this wholly new transportation paradigm. Thank you.