Securing America's Future Energy

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# Using Fuel Efficiency Regulations to Conserve Fuel and Save Lives by Accelerating Industry Investment in Autonomous and Connected Vehicles

The Trump administration and the state of California are currently engaged in parallel processes to determine the proper level of fuel economy and greenhouse gas emission standards for light-duty vehicles for model years 2022–2025 and beyond. While California seeks to retain existing standards to meet the state's environmental objectives,[1] the federal government recently announced that the 2022–2025 standards are "not appropriate" and is now undertaking a new rulemaking.[2] The components of a compromise have been identified, in which regulators offer automakers flexibility to meet standards in the near term in exchange for increased stringency over a longer period of time.

The National Highway Traffic Safety Administration (NHTSA) is the federal agency statutorily mandated to regulate both fuel economy and safety. Historically, there has been concern that increasing fuel economy decreases safety because smaller and lighter cars are presumed to be less safe, and this concern is reemerging in the current process to set fuel economy rules for the years 2022–2025. Fortunately, NHTSA's most recent data demonstrates that the move to a footprint-based standard in 2012 (an approach in which the stringency of the standards is based on the size of the car) substantially addressed the size vs. safety concern.[3]

More consequentially, the industry is entering a phase that—if ushered in successfully—can both increase fuel economy and enhance safety benefits in a manner through which these goals reinforce each other. The rise of autonomous vehicle technology can lead to dramatic increases in vehicle safety while simultaneously driving fuel economy improvements. While these technologies are under development and the extent of their benefits is still emerging, test results offer the promise of substantially increased efficiency and improved safety through vehicle- and system-level improvements. Yet because these technologies are so new, there is neither sufficient deployment

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1 Office of Governor Edmund G. Brown, Jr., "Governor Brown Issues Statement on U.S. EPA Decision to Weaken Clean Car Standards," (Apr. 2, 2018) available at www.gov.ca.gov/2018/04/02/governor-brown-issues-statement-on-u-s-epa-decision-to-weaken-clean-car-standards-2/; Letter from Governor Brown to EPA Administrator Scott Pruitt, (Mar. 15, 2017) available at https://www.gov.ca.gov/wp-content/uploads/2017/09/3.15.17_Letter_to_EPA.pdf.

2 Environmental Protection Agency, "Mid-term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022-2025 Light-duty Vehicles," (Apr. 2, 2018) ("Mid-Term Evaluation") available at www.epa.gov/sites/production/files/2018-04/documents/mte-final-determination-notice-2018-04-02.pdf.

3 Puckett, S.M. and Kindelberger, J.C. 2016. *Relationships Between Fatality Risk, Mass, and Footprint in Model Year 2003-2010 Passenger Cars and LTVs.* Preliminary report prepared for the National Center for Statistics and Analysis, National Highway Traffic Safety Administration, Washington, D.C. June, 2016.

nor adequate understanding of the degree to which these innovations can improve vehicle efficiency and decrease emissions. Moreover, such technologies are not easily accounted for in the current regulatory regime. SAFE estimates, based on independent fuel efficiency modeling, that an 18–25 percent system-wide fuel economy savings can be realized by using existing driver assist and connected vehicle technology, and that thousands of lives can be saved annually.

Fortunately, the off-cycle credit program within the Environmental Protection Agency's (EPA) regulations to limit greenhouse gas emissions from light-duty vehicles provides a mechanism that could be used to accelerate the real-world testing, and eventual incorporation, of these technologies into the fuel economy program—not only resolving the safety-fuel economy issue once and for all but, more importantly, saving thousands of additional lives while providing further reductions in fuel demand. As part of the current ongoing discussions between automakers and regulators, parties should agree to allow automakers to earn compliance credits (for 3–5 years) as part of a research program to deploy autonomous and connected vehicle technology, collect data about the technology's performance, and share the data with regulators so that they can together evaluate the effectiveness of this emerging technology. To the extent that the testing demonstrates improvement in efficiency, lower emissions and increased safety, regulators can use the data to support permanently accounting for such efficiencies in future compliance periods.

## Background

The Trump administration is currently revisiting fuel economy and greenhouse gas emission standards established by the Obama administration in cooperation with the state of California.[4] In 2012, EPA established emission standards for model years (MYs) 2017–2025 and NHTSA established fuel economy standards for MYs 2017–2021,[5] as its statutory authority allows for setting standards for no longer than five years at a time.[6] Working together with California's regulator, the California Air Resources Board (CARB), which has legal authority under the Clean Air Act to establish its own standards,[7] the three regulating entities developed coordinated standards that allowed for consistent automotive manufacturing standards for the entire nation.[8] Because of the five-year limitation on NHTSA's authority, the regulators committed to complete a Mid-Term Evaluation by April 2018 to determine if the EPA standards required adjustment, and lay the foundation for the extension of NHTSA standards for MYs 2022-2025.[9]

There appear to be four primary positions in the stakeholder community. CARB wants to maintain aggressive emission reduction and fuel economy targets, due to its concern about the effect of

4 See, Mid-Term Evaluation.

5 Environmental Protection Agency and National Highway Traffic Safety Administration, *2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards*, 77 Fed. Reg. 62,624 (Oct. 15, 2012) (CAFE Rule).

6 49 U.S.C. 32902 (b)(3)(B).

7 California has the authority to issue its own standards, following issuance of a waiver from EPA, that shall be granted unless: 1) California's determination is arbitrary and capricious, 2) California does not need such standards to meet compelling and extraordinary conditions, or 3) California standards and accompanying enforcement procedures are not consistent with CAA requirements for motor vehicles. 42 U.S.C. 7543(b).

8 CAFE Rule at 62630.

9 CAFE Rule at 62784.

vehicle emissions on public health and the environment.[10] EPA has determined that the current standards are too aggressive and warrant a re-examination.[11] Most automakers, concerned about the difficulty of meeting the standards with fuel prices lower than forecast and consumer preferences different than expected, are advocating for CARB and the federal regulators to reach an agreement to maintain the national standard and avoid litigation while providing some flexibility in the near term.[12] Finally, NHTSA has indicated it remains concerned about safety, citing increasing numbers of traffic fatalities in the past several years.[13]

Despite these competing priorities, several outside groups and the industry have identified the basic structure of an agreement, with regulators offering automakers some increase in flexibility through MY 2025 in exchange for tighter standards between MYs 2026–2030, which would allow time for automakers to fully navigate the revolution—that all stakeholders agree is happening—to a system dominated by new technologies and business models, including connectivity, autonomy, ridesharing, and electrification. In particular for this Issue Brief, the current negotiation offers an opportunity to establish incentives to begin deploying and testing driver assist and connected vehicle technology, which could open the door to transformational improvements in fuel economy and emission reductions in the future while saving lives. This approach would also address NHTSA's core mandate, to improve road safety and reduce traffic injuries and deaths.[14]

## The Opportunity

Autonomous vehicles (AVs) are a breakthrough technology, and many of their components or partial autonomous functions, which are already incorporated or can be incorporated into new vehicles, offer efficiency and safety improvements on their own. The development and adoption of AV technology will represent the greatest shift in automotive technology since the Model T and has the potential to rank alongside personal computing and the internet as one of the greatest technological shifts in our society in the post-World War II era. When AVs are significantly safer than current automotive technology, they are likely to substantially reduce the number of vehicle accidents as well as the injuries and costs associated with them, potentially saving tens of thousands of lives and eliminating millions of injuries each year in the United States alone.[15] The ability for AVs to closely coordinate with other vehicles will allow vehicles to travel in closer proximity to each other, increasing road capacity and reducing travel times.[16] If fully automated, AVs can offer increased

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[10] John Lippert and Ryan Beene, "California Sets Demands for Auto-Emission Talks With Trump" Bloomberg News (Sept. 27, 2017) available at www.bloomberg.com/news/articles/2017-09-22/california-sets-demands-for-talking-emissions-targets-with-trump.

[11] See, Mid-Term Evaluation at p. 1

[12] See, e.g., Auto Alliance, "Auto Alliance Statement in Response to EPA's Announcement about the Midterm Review of the Fuel Economy/GHG Program," (Apr. 2, 2018) available at autoalliance.org/2018/04/02/auto-alliance-statement-response-epas-announcement-midterm-review-fuel-economy-ghg-program/.

[13] National Highway Traffic Safety Administration, "USDOT Releases 2016 Fatal Traffic Crash Data," (October 6, 2017) available at www.nhtsa.gov/press-releases/usdot-releases-2016-fatal-traffic-crash-data.

[14] National Highway Traffic Safety Administration, "About NHTSA," available at www.nhtsa.gov/about-nhtsa.

[15] Kalra, Nidhi, and David G. Groves. *The Enemy of Good: Estimating the Cost of Waiting for Nearly Perfect Automated Vehicles*. Rand Corporation, 2017.

[16] James Anderson et al., *Autonomous vehicle technology: A guide for policymakers*, Rand Corporation at 5 (2016).

mobility to the disabled, seniors, and low-income populations with less access to affordable transportation, transforming their lives. Fully automated AVs can also give drivers one thing of tremendous value to most Americans—an increase in personal or productive time—as time that was once spent operating a car can be reallocated while the car drives itself.

If AVs are widely deployed in ride sharing applications, as anticipated, the effects could extend further. The dominant paradigm since the invention of the car has been private vehicle ownership, but that could shift once users find it more convenient—and cost-effective—to use ride-sharing services rather than maintaining and operating their own car. That shift could affect where people choose to live and work, and where vehicles are stored, with the need for parking substantially reduced. Likewise, paring AVs with electric vehicle (EV) technology, a deployment path that appears likely because of the engineering and cost advantages of using an electric powertrain for AVs,[17] can lead to transformative shifts in our patterns of fuel usage by reducing the amount, and changing the type, of energy that we consume—improving our energy and national security in the process. Fleet autonomous vehicle deployments are expected to leverage electric drivetrains because commercial fleet operators will prioritize the total cost of ownership, and electric vehicles offer significant fuel and maintenance cost savings. The size of the opportunity is reflected in the attention that automakers and investors are directing towards AV innovation. A recent study from The Brookings Institution identified over 160 investments valued at nearly $80 billion that have been made in AV technology between 2014 and 2017, noting that it is reasonable to assume that investment in AV technology is much higher.[18]

A major obstacle to incorporating the benefits of AVs into the standards is the lack of data that demonstrates their relevance to emissions or fuel consumption. Understanding the real-world impact of these technologies is critical to designing a regulatory approach that maximizes fuel economy and safety. Generating robust data that proves the technologies' effectiveness is the first fundamental step to incorporating these potential benefits into the regulations. SAFE believes, based on fuel efficiency modeling, that an 18–25 percent system wide fuel economy savings can be realized using current driver assist and connected vehicle technology. In addition, other research indicates that fatalities will be reduced by the thousands every year using this same technology.[19] A program that incentivizes real world testing and data sharing should be a priority for all government agencies.

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[17] Lipson, Hod, and Melba Kurman. *Driverless: intelligent cars and the road ahead*. MIT Press (2016) and Jeffery Greenblatt and Susan Shaheen, Automated Vehicles, On-Demand Mobility, and Environmental Impacts, Current Sustainable/Renewable Energy Reports (2015).

[18] Cameron F. Kerry and Jack Karsten, "Gauging investment in self-driving cars," Brookings Institution (Oct. 16, 2017) available at www.brookings.edu/research/gauging-investment-in-self-driving-cars/.

[19] National Highway Traffic Safety Administration, "*Vehicle-to-Vehicle Communications: Readiness of V2V Technology for Application*," at xvi (Aug. 2014) available at www.nhtsa.gov/press-releases/us-department-transportation-issues-advance-notice-proposed-rulemaking-begin. The report includes preliminary estimates of safety benefits that show two safety applications - Left Turn Assist (LTA) and Intersection Movement Assist (IMA) – could prevent up to 592,000 crashes and save 1,083 lives saved per year. We chose those two applications for analysis at this stage because they are good illustrations of benefits that V2V can provide above and beyond the safety benefits of vehicle-resident cameras and sensors. Of course, the number of lives potentially saved would likely increase significantly with the implementation of additional V2V and V2I safety applications that would be enabled if vehicles were equipped with DSRC capability.

## Fuel Economy Standards and Autonomous Vehicles

AVs have the ability to offer the greatest leap in fuel economy—in the shortest period of time—since the program's inception more than 40 years ago. Some of the "building block" components of AVs, including vehicle-to-vehicle, or vehicle-to-infrastructure connectivity and advanced driver assist systems, can allow cars to operate more efficiently and safely. Since accidents are a major contributor to congestion, reducing accidents improves system throughput and efficiency.[20] These and other benefits can substantially improve vehicle fuel economy and reduce fuel consumption both in individual vehicles and the transportation system as a whole. Reflecting the potential offered by AV technology, one analysis suggests that if the most far-reaching business models and structural changes enabled by AVs are adopted by the entire fleet, road capacity can be doubled.[21]

While the savings are significant, the structural limitations of the fuel economy regime make it difficult to maximize—or even minimally incentivize—these emerging benefits.[22] The fuel efficiency framework that NHTSA developed in the 1970s does not have the flexibility to capture efficiencies resulting both directly and indirectly from vehicle automation and connectivity. For both NHTSA and EPA standards, vehicle compliance is measured by running the vehicle through a predetermined set of accelerations which aim to mimic real-world conditions. This test does not have the flexibility to account for the ability of AVs to improve fuel efficiency performance by accelerating/decelerating more smoothly than humans, avoiding congestion-causing accidents, or having the foresight to take alternative, less congested routes. Including technologies in the framework of fuel efficiency regulations has been shown to accelerate adoption;[23] conversely the continued exclusion of autonomous features from this framework could delay or even permanently limit the fuel savings benefits offered by AVs and their component technologies—as has been the case with other voluntary safety-related technologies. The Insurance Institute for Highway Safety examined the rollout of safety technology and estimates that it takes 30 years for equipment to become standard on new vehicles. [24] The report estimates that, left to the market, technologies like the ones proposed in this Issue Brief (forward collision warning, blind-spot monitoring, lane-departure warning), will only become standard on all vehicles by 2043. The proposal described here would accelerate that adoption by decades, potentially saving tens of thousands of lives and million of barrels of oil.

There is a solution which saves both lives and fuel. The EPA has the authority and flexibility to address the structural problems of the program—and has used this flexibility in the past through its

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[20] See, e.g., Anthony Downs, "Traffic: Why It's Getting Worse, What Government Can Do," Brookings (Jan. 1, 2004); David Schrank, et al. "2015 urban mobility scorecard." University of Texas, at 5 (2015); NHTSA, "The Economic and Societal Impact Of Motor Vehicle Crashes, 2010 (Revised)," at 50-112 (May 2015) available at crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812013.

[21] Dimitris Milakis, Bart van Arem & Bert van Wee. "Policy and Society Related Implications of Automated Driving: A Review of Literature and Directions for Future Research," Journal of Intelligent Transportation Systems, 21:4, 324-348, 330, 340 (2017).

[22] Mersky, Avi Chaim, and Constantine Samaras. "Fuel economy testing of autonomous vehicles." Transportation Research Part C: Emerging Technologies 65 (2016): 31-48

[23] Zoepf, Stephen, "Automotive Features: Mass Impact and Deployment Characterization," M.S. Thesis, at 23, Massachusetts Institute of Technology (2011).

[24] See, e.g., Keith Laing," Car-safety features stuck in slow lane," Detroit News (Mar. 5, 2018), available at www.detroitnews.com/story/business/autos/2018/03/05/car-safety-features-slow-coming/111097598/.

off-cycle credit program.[25] EPA could use that same flexibility, working with NHTSA, to help incentivize the accelerated deployment of connected and autonomous technologies into the light-duty fleet, for the purposes of testing the real-world emissions and safety benefits. Automakers would share the resulting data to verify the savings captured. This effort by EPA would help NHTSA achieve its two congressionally-mandated objectives of fuel economy for national security and safety.

Utilizing the off-cycle credit program for this kind of research agenda would solve two problems: The scale of commercialization and the availability of real-world data. Vehicle connectivity technology is nascent and has yet to penetrate the fleet in meaningful numbers; inclusion in a fuel efficiency framework could accelerate adoption of advanced driver-assist systems (ADAS) and encourage optimizing such systems for efficiency.[26] There remains insufficient data to fully evaluate the effectiveness of these technologies at improving fuel efficiency and reducing vehicle emissions. In addition, such a research program could identify ways real-world data could be used to more effectively assess technologies that are already part of the off-cycle credit program.

Perhaps most importantly from a process perspective, such changes could open the pathway to an agreement on fuel economy and emissions with the state of California, maintain a program that is national in scope, and create additional certainty that the automakers seek.

## How Vehicle Automation Improves Safety

According to NHTSA's analysis, performed on a small subset of crashes, vehicle to vehicle communication (V2V) could save over 1,000 lives a year.[27] A recent BCG report concluded that ADAS could prevent 28 percent of all crashes in the United States if all cars were equipped with ADAS features *that are available today*. The technologies could prevent approximately 9,900 fatalities and save about $251 billion to society each year.[28] To put these numbers in perspective, NHTSA estimates there are roughly 38,000 traffic fatalities on US roads and highways every year. ADAS, in conjunction with adaptive headlights, would improve outcomes in nearly half of fatal crashes. By comparison, seatbelts and frontal air bags saved approximately 15,000 and 2,800 lives in 2007, the latest year studied.[29] If widely deployed, ADAS technologies would be poised to join seatbelts and air bags as high-impact safety technologies.

[25] 40 CFR 86.1869-12.

[26] ARPA-E, "Next-Generation Energy Technologies for Connected and Automated On-Road Vehicles Program Description," (Nov. 2, 2016) available at arpa-e.energy.gov/?q=arpa-e-programs/nextcar.

[27] National Highway Traffic Safety Administration, "U.S. Department of Transportation Issues Advance Notice of Proposed Rulemaking to Begin Implementation of Vehicle-to-Vehicle Communications Technology," (Aug. 18, 2014), available at www.nhtsa.gov/press-releases/us-department-transportation-issues-advance-notice-proposed-rulemaking-begin.

[28] Boston Consulting Group Inc. and Motor & Equipment Manufacturers Association, "A Roadmap to Safer Driving through Advanced Driver Assistance Systems," at 2, 13, 14 (2015), available at www.mema.org/sites/default/files/MEMA%20BCG%20ADAS%20Report.pdf.

[29] National Highway Traffic Safety Administration, "Lives Saved Calculations for Seat Belts and Frontal Air Bags," at p. 2 (Dec. 2009) available at crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/811206.

## How Vehicle Automation Improves Efficiency

There are several different pathways for new AV technology to improve vehicle efficiency and reduce fuel consumption. Some of these effects occur at the vehicle level. Other improvements occur when new transportation-related systems are deployed. Still others are the result of wide scale deployment of full AV technology. An initial review of the literature shows the potential to improve fuel economy by up to 25 percent when technologies are optimized and aggregated.[30] While more data is needed, the potential is incredibly promising and warrants serious attention. Some of the technologies and impacts are described below.

### Vehicle-Level Impacts

A new technology has a "vehicle level" impact if it improves the fuel efficiency of the vehicle equipped with the technology. This is significant because the vehicle can operate more efficiently entirely on its own, and those efficiency gains can often be measured if a testing procedure is designed to capture them. Some examples of technologies with vehicle level benefits are:

- ***Advanced Driver Assistance System***: An Advanced Driver Assistance System describes a suite of technologies that substitute for some driving decisions—prominent examples include Automatic Emergency Braking and Lane Keeping Assist. An initial review of data collected from a fleet testing ADAS systems demonstrated more than a two percent improvement in fuel efficiency, and preliminary evidence suggests that considerably higher gains are possible.[31]
    - Researchers at Carnegie Mellon University demonstrated that Adaptive Cruise Control (ACC) can be "tuned" to leverage significant fuel savings. In the absence of a policy incentive, ACC could actually reduce energy efficiency.[32]
    - ***ARPA-E's NEXTCAR Initiative:*** ARPA-E is an agency at the Department of Energy that advances high-potential, high-impact energy technologies with the capability to radically improve U.S. economic prosperity, national security, and environmental well-being. ARPA-E's NEXTCAR Initiative is funding a series of projects to develop vehicle automation technology that use connectivity and automation to co-optimize vehicle dynamic controls and powertrain operation, reducing energy consumption of the vehicle, and—in some applications—the vehicle fleet. NEXTCAR's goal is to enable at least an additional 20 percent reduction in energy consumption of future connected and automated vehicles. NEXTCAR's modeling has validated that, under certain conditions, this approach could result in a greater than 20 percent reduction in vehicle energy consumption. The program's goal is to commercialize this energy-saving technology at a cost of under $1,000 per car and under $3,000 per heavy-duty vehicle.[33]

### System-Level Impacts

A network effect occurs when the larger the numbers of people or participants to use a service or product, the greater the value of the service or product. For instance, e-mail is a more effective

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[30] SAFE analysis and additional modeling of existing literature.

[31] Dish Network Data from Pilot Program; and SAFE interviews with industry; "Case Study: Dish saves fuel with Mobileye technology", *FleetOwner* (May 6, 2016).

[32] Mersky and Samaras (2016).

[33] Chris Atkinson, "NEXTCAR – Next Generation Energy Technologies for Connected and Automated On-Road Vehicles," Presentation to NEXTCAR Launch Event (Apr. 6, 2017) available at arpa-e.energy.gov/sites/default/files/2_ARPA-E_NEXTCAR_Kickoff.pdf.

means of communicating when more people have e-mail because there are more people you can reach with it. There are new AV technologies that have network effects that can make the transportation system more efficient. If every car had these capabilities, vehicle efficiency should improve and the number of vehicle accidents should decline. Accident-related congestion in the United States wastes nearly one billion gallons of fuel and creates about 9.5 million tons of $CO_2$ on an annual basis.[34] ADAS and connectivity could mitigate the causes of about 85 percent of crashes, which illustrates that the system-level benefits are considerable.[35]

The wide-scale adoption of collision reduction technology and vehicle connectivity can be major sources of energy savings:

- ***Cooperative Adaptive Cruise Control (CACC):*** CACC is a type of cruise control that smooths out vehicle speed and acceleration, reducing fuel consumption. Because vehicles would be nearly-instantaneously responsive to changes in other vehicle speeds, more cars could fit on the roads without increasing road capacity or reducing vehicle speeds. Significant adoption of CACC could enable smoother traffic flow, which would improve both individual vehicle efficiency and highway capacity.[36]

- ***Collision Avoidance Technology:*** An industry regulatory filing by Mercedes-Benz USA made the following claims, based in part on research from the insurance industry.[37]
    - Using Lane Keeping Assist and Blind Spot Assist in all vehicles would reduce crashes by five percent.
    - Forward Collision Warning and Adaptive Brake Assist in all vehicles would reduce crashes by 15 percent.
    - Emergency Braking and ACC in all vehicles would reduce crashes by 18 percent.

- ***Vehicle to Vehicle and Infrastructure Communication:*** This technology shares information between vehicles in close proximity to each other. When widely deployed, it improves the effectiveness of ACC because it can monitor what is happening several cars ahead and because it can direct a vehicle on a route that reduces congestion, reduces idling and saves fuel.[38]

## Full Automation will have Far Reaching Implications

Recognizing the importance of a systemwide approach, traditional automotive companies such as Ford and GM are working to rebrand themselves as "mobility companies." Indeed, among the many aspects of our transportation system that would be affected by broad adoption of AVs are

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[34] *2015 Urban Mobility Scorecard*. Texas A&M Transportation Institute and Inrix (2015); Mercedes-Benz USA. "Request for Comment (RFC) on Reconsideration of the Final Determination of the Mid-Term Evaluation of Greenhouse Gas Emission Standards for MY 2022-2025 Light-Duty Vehicles," (2017).

[35] Frost & Sullivan, "Vehicle-to-Everything Technologies for Connected Cars" (Aug. 2017).

[36] Steven Shladover, Dongyan Su, and Xiao-Yun Lu, "Impacts of Cooperative Adaptive Cruise Control on Freeway Traffic Flow," Transportation Research Record 2324, at 63-70, (2012).

[37] Comments of Mercedes-Benz USA, LLC to Proposed Rule to Establish Light-Duty Vehicle Greenhouse Gas Emissions Standards and Corporate Average Fuel Economy Standards for Model Year 2017 and Beyond; Docket Nos. EPA-H1-OAR-2010-0799; FRL-9495-2; NHTSA-2010-0131 at A-10, A-11, (2012).

[38] Department of Transportation, "Preliminary Regulatory Impact Analysis: FMVSS No. 150 Vehicle-to-Vehicle Communication Technology for Light Vehicles," (Nov. 2016) available at www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/v2v_pria_12-12-16_clean-2.pdf.

improvements in the efficiency of the vehicles and the choice of fuels that we use.

- *Advanced Fuels:* Both economics and engineering suggest that the shift to shared, autonomous vehicles will go hand-in-hand with increasing use of advanced fuels.[39] AVs have lower operational and maintenance costs, as there are fewer moving parts and maintenance requirements for an electric vehicle. Full automation is likely to render vehicle ownership a less attractive economic proposition and allow on-demand fleets to serve a large fraction of travel demand.[40] Modeling shows that economic considerations make it likely that such vehicles would use an advanced fuel source (particularly electrification). Such vehicles could decrease emissions by 90 percent relative to conventional, human-driven cars and by about 70 percent relative to hybrids.[41]

- *Light Weight Connected Vehicles*: A recent RAND Corporation report projects that by 2050 connected, lightweight AVs could reach 300-500+ MPG for lightweight, single-occupant pod cars.[42]

- *Autonomous Vehicle Car Sharing and Ride Sharing:* AVs will be used in car and ride sharing services, providing vehicle access to individuals who do not own the vehicle outright (such as a time share model) or individual rides to individuals traveling together in a vehicle where they are contracting a service but have no ownership stake in the vehicle (such as Uber or Lyft).
  - Vehicle performance and acceleration may be important to vehicle owners who value the prestige or experience of owning a "muscle car,"[43] but such features are less important for on-demand vehicles because riders are largely indifferent as to whether the vehicle they are riding in—and do not own—is capable of rapid acceleration. Vehicles that are engineered for efficiency instead of performance can improve efficiency by as much as 20 percent.[44]
  - A UC Berkeley study found that households with car sharing subscriptions reduced their transportation greenhouse gas footprint by up to 18 percent.[45]

In short, connectivity and autonomous vehicle technology will have a broadly positive impact on the efficiency of the U.S. transportation system. While the downstream impacts of broad AV adoption

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[39] Gardner, Greg, "*Our Autonomous Future Will Likely Be an Electric One, Here's Why*," Detroit Free Press (Sept. 23, 2016 available at http://www.govtech.com/fs/Our-Autonomous-Future-Will-Likely-Be-an-Electric-One-Heres-Why.html.

[40] Securing America's Future Energy (SAFE), *A National Strategy for Energy Security: The Innovation Revolution*, at 88, 91 (2016).

[41] Greenblatt, J. B., & Saxena, S., "Autonomous taxis could greatly reduce greenhouse-gas emissions of US light-duty vehicles," *Nature Climate Change*, *5*(9), 860-863 (2015).

[42] James Anderson et al., *Autonomous vehicle technology: A guide for policymakers*, Rand Corporation, at 31 (Figure 2.6) (2014).

[43] Zoepf (2011).

[44] Austin Brown, Jeff Gonder, and Brittany Repac, "An Analysis of Possible Energy Impacts of Automated Vehicles", *Road Vehicle Automation* (2014).

[45] Elliot Martin and Susan Shaheen, "Impacts of car2go on Vehicle Ownership, Modal Shift, Vehicle Miles Traveled, and Greenhouse Gas Emissions: An Analysis of Five North American Cities," Innovative Mobility Research and Transportation Sustainability Research Center at UC Berkeley, Working Paper July 2016, available at innovativemobility.org/wp-content/uploads/2016/07/Impactsofcar2go_FiveCities_2016.pdf.

are not fully understood, there is considerably more certainty on the impacts of the building block technologies that compose these systems. By utilizing fuel efficiency policies to better evaluate these technologies, the U.S. can not only create more opportunities to save fuel in the short-term but, can also begin the process of modernizing energy policy for the impacts of AVs for the coming decades.

### Modeling of Fuel Economy Benefits

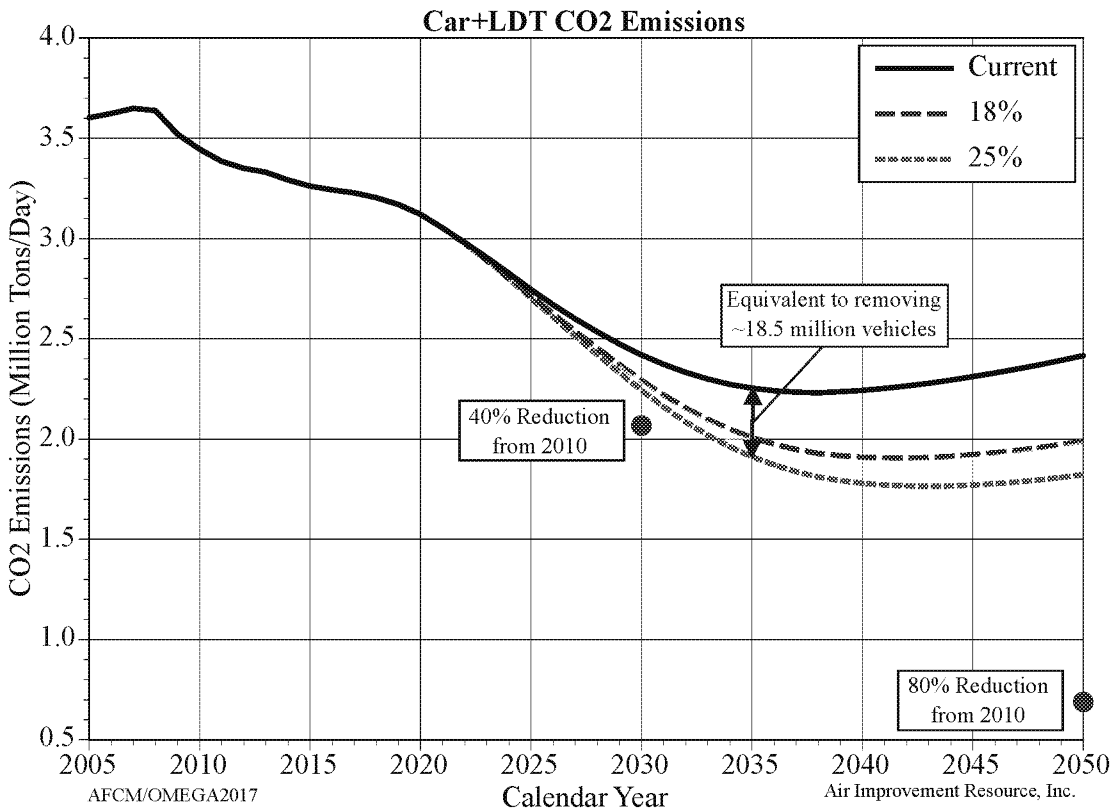
To examine the impact of these emerging autonomous and connected technologies, SAFE contracted Air Improvement Resource,[46] to model the potential fuel economy savings if these technologies were widely deployed in the fleet. A review of two dozen studies underpinned the analysis and identified the following set of potential savings. Most of these savings are additive and, together, identify the potential to reduce fuel consumption by 18 to 25 percent if deployed throughout the fleet. The results are summarized in the chart below.

| Strategy | Vehicle Benefit (estimated over all driving, even though main benefit may be on highways) | Additional Benefit if Majority of Vehicles are Equipped | Mechanism |
|---|---|---|---|
| Driver enabled adaptive cruise control (base) | 7%-10% (assumes enabled 100% on highways) | None | Smoother driving |
| Crash warning systems | 0% | 3% | Less total crashes and therefore less idle/year |
| V2V info sharing | +2-4% | Incl in vehicle benefit | Smoother driving Level 2 |
| V2I info sharing | +1-3% | Incl in vehicle benefit | Smoother driving Level 3 and congestion avoidance |
| AVs and CAVs (w/platooning) | + 5% | Incl in vehicle benefit | Smoother driving Level 4, congestion avoidance and platooning |

The modeling further compared what this level of savings could mean for the current fuel economy program as well as what it might mean for the longer-term targets identified as necessary to reach environmental objectives. For illustration purposes, we apply California's CO2 targets to the national fleet. The chart below shows the AV technology potential in terms of emissions reduction relative to the current standard and the longer-term goals established by California and other stakeholders for 2030 and 2050. The chart shows the current EPA 2022-2025 standards (represented by the solid black line) and their associated CO2 emissions reductions through 2050. The red line represents the lower bound estimate of 18 percent reduction while the green line represents the maximum 25 percent reduction potential. The area between the black line (current standards) and the green line

46 Air Improvement Resource, Inc. provides engineering and consulting services in the area of mobile and stationary source emissions modeling and technology evaluation. They are experts in EPA emissions modeling.

(25 percent reduction) represents the potential savings these autonomous and connected technologies could have on emissions—equaling the removal of 18.5 million vehicles from the road in 2035. The red dots represent the national equivalent of the goals set by California and other advocates as the necessary reductions in transport CO2 emissions in 2030 (40 percent reduction) and 2050 (80 percent reduction). A real-world test program that demonstrates the viability of these benefits could lead to much greater success in achieving the environmental and fuel efficiency goals for 2030 and put the transportation sector on a more promising trajectory toward the goals for 2050.




## Conclusion

To help regulators capture the benefits of this new technology, we must accelerate our understanding of its potential fuel-saving and safety benefits. To achieve this, federal regulators should partner with automakers to develop a program that deploys and collects data regarding the effectiveness of new autonomous and connected technologies to earn temporary compliance credits for the emissions and fuel economy programs. This initiative will lay the foundation for a more complete accounting of the increase in efficiency and reduction in emissions that they offer so that their benefits can be properly assessed on a permanent basis as part of these regulatory programs. Ultimately, if the technology proves effective, these technologies and business models should be incorporated into the off-cycle credit program, which is administered by EPA in consultation with NHTSA.

Autonomous and connected vehicle technology could radically improve the fuel-efficiency of the light-duty vehicle fleet, but this potential cannot be fully examined or realized under current regulatory structures. By offering automakers credit for a defined period of time for deploying AV technology and collecting data that automakers and regulators can use to assess the technology's effectiveness, regulators can remove a substantial roadblock to the development and deployment of these potentially transformative innovations. Research estimates that ADAS could prevent 28 percent of all crashes in the United States if all cars were equipped with features that are available today, preventing approximately 9,900 fatalities and saving $250 billion in societal costs every year. Furthermore, SAFE's analysis shows that 18-25 percent system-wide fuel economy saving can be realized by using existing diver assist and connected vehicle technology. By finding a way to constructively incorporate vehicle automation into the emissions and fuel economy programs, the federal government could accelerate the commercialization of life-saving and fuel-reducing technologies while simultaneously keeping the U.S. industry at the forefront of global automotive innovation.

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