AUTOMATED DRIVING AND THE CLEAN AIR ACT

NATHAN M. P. TAYLOR[*]

* Executive Editor, New York University Environmental Law Journal 2015–2016; J.D. 2016 *cum laude*, New York University School of Law. This Article benefited greatly from the comments, criticism, and guidance of Richard Revesz, Katrina Wyman, Nancy Marks, Janice Dean, Robert Schuwerk, Matthew Oakes, Bryant Walker Smith, Aaron Levine, David Boggs, and Therese Langer. All remaining errors are my own. Thanks also to the staff of the NYU Environmental Law Journal for their fine work.

INTRODUCTION

On March 13, 2004, fifteen teams of scientists and engineers gathered at the start of a 142-mile course in the Mojave Desert for the inaugural DARPA Grand Challenge.[1] Whichever team's self-driving car crossed the finish line first would claim not only a $1 million prize,[2] but a place in history as the pioneers who kicked off a revolution in mobility. The teams had already beaten out ninety-one others just to be in the race.[3] There was undoubtedly an electric feeling in the air as the robot vehicles rolled through the starting blocks, and shrank into the distance on their long and lonely journeys. However, the journeys ended sooner than anticipated. The best performing vehicle, from the team from Carnegie Mellon University, made it only seven and a half miles before it caught on a berm and ignited.[4] The rest of the vehicles failed to make it even that far, and the prize went unclaimed. Undeterred, the engineers returned home to prepare for a rematch eighteen months later.[5] And in 2005, the robot Stanley (from Stanford) claimed the prize.[6]

In the ensuing years, a new race has commenced, with some of the largest and most prestigious vehicle and technology companies in the nation drawing rapidly toward the finish line. The finish line is no longer Buffalo Bill's Casino in Primm, Nevada, but the marketing of a fully automated vehicle. In 2015, Tesla Motors defied skeptics by introducing a "self-driving" feature that can maintain both speed and lane position.[7] Automated safety features,[8] and convenience features such as "parking assist"

1 *See The DARPA Grand Challenge: Ten Years Later*, DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (Mar. 13, 2014), http://www.darpa.mil/news-events/2014-03-13; Marsha Walton, *Robots Fail to Complete Grand Challenge*, CNN (May 6, 2004), http://www.cnn.com/2004/TECH/ptech/03/14/darpa.race/.

2 *See id.*

3 *See id.*

4 *See id.*

5 *See* DEFENSE ADVANCED RESEARCH PROJECTS AGENCY, *supra* note 1.

6 *See id*.

7 *See* Aaron M. Kessler, *Tesla Adds High-Speed Autonomous Driving to Its Bag of Tricks*, N.Y. TIMES (Oct. 15, 2015), http://www.nytimes.com/2015/10/16/automobiles/tesla-adds-high-speed-autonomous-driving-to-its-bag-of-tricks.html.

8 *See, e.g.*, *Guide to Safety Features*, CONSUMER REPORTS (June 2016), http://www.consumerreports.org/cro/2012/04/guide-to-safety-features/index.htm (describing "safety features to look for" when shopping for a car, including semi-automated features like electronic stability control, emergency braking system,

have already reached the market and are available in many vehicles.[9] In its waning days, the Obama Administration launched an ambitious agenda to fund automated driving technology research and infrastructure, and to leverage regulatory authority to help pave the way for "self-driving cars" in the future.[10]

While vehicles capable of automated driving have not become commercially available, the technology has advanced to the point that policymakers are grappling with knotty legal and regulatory questions these vehicles pose. Questions of liability, safety, and privacy all remain to be decided. With the first deaths attributable to fledgling automated driving technology came a renewed interest in who will bear liability for machine-caused collisions, and how safety regulators should approach automated vehicles.[11] It is not clear whether leading firms like Google, which have access to so much information already, should be left to decide on their own how to manage computerized records of passengers' every movement.[12] The urgency with which these questions are discussed is growing, and a robust debate has already begun.

Less attention has been paid to how environmental laws should address automated driving. It is an open question whether automated driving will bring greater efficiency and environmental

and adaptive cruise control, etc.).

9 *See, e.g.*, *Park Assist*, VOLKSWAGEN, http://en.volkswagen.com/en/innovation-and-technology/technical-glossary/parklenkassistent_park_assist.html (last visited Nov. 8, 2016).

10 *See, e.g.*, *Secretary Foxx Unveils President Obama's FY17 Budget Proposal of Nearly $4 Billion for Automated Vehicles*, U.S. DEP'T OF TRANSP. (Jan. 14, 2016), https://www.transportation.gov/briefing-room/secretary-foxx-unveils-president-obama%E2%80%99s-fy17-budget-proposal-nearly-4-billion; *see also* Tim Grant, *Feds Offer National Guidelines for Self-Driving Vehicles*, PITTSBURGH POST-GAZETTE (Sept. 21, 2016, 12:00 AM), https://www.post-gazette.com/news/transportation/2016/09/21/Feds-offer-national-guidelines-for-self-driving-vehicles/stories/201609210038 (discussing new regulations of autonomous vehicles).

11 *See generally* NIDHI KALRA ET AL., LIABILITY AND REGULATION OF AUTONOMOUS VEHICLE TECHNOLOGIES (2009); JOHN VILLASENOR, PRODUCTS LIABILITY AND DRIVERLESS CARS: ISSUES AND GUIDING PRINCIPLES FOR LEGISLATION (2014); GILLIAN YEOMANS, AUTONOMOUS VEHICLES: OPPORTUNITIES AND RISKS FOR INSURANCE (2014); Neal E. Boudette, *Autopilot Cited in Death of Chinese Tesla Driver*, N.Y. TIMES (Sept. 14, 2016), http://www.nytimes.com/2016/09/15/business/fatal-tesla-crash-in-china-involved-autopilot-government-tv-says.html.

12 *See* Jack Boeglin, *The Costs of Self-Driving Cars: Reconciling Freedom and Privacy with Tort Liability in Autonomous Vehicle Regulation*, 17 YALE J. L. & TECH. 171, 177 (2015).

benefit, or will simply facilitate increased travel resulting in environmental harms.[13] The answer to this question will, to some extent, depend on government policy guiding the development pathway of the technology.

For purposes of emissions, the federal government, through the Clean Air Act's technological regulations, controls how much pollution a motor vehicle can emit, while states and cities regulate drivers' use of vehicles and manage emissions arising from that use.[14] However, emerging automated driving technology may have dramatic repercussions for both automobile technology and usage. Automated driving systems will give vehicle technology a much larger role in decisions formerly reserved to drivers: how and where vehicles travel, the routes they take, where they are stored, and who owns them. As automated driving erodes the boundary between the Clean Air Act's authority over technology and states' authority over driving, policymakers must decide how best to consider its environmental effects.

This Article explores the implications of the advent of automated driving for the Clean Air Act, and identifies a number of ways that federal and state actors can engage to ensure automated driving technology develops in an environmentally beneficial manner. Part I gives an overview of the current federal government response to automated driving. Part II explores the literature on how automated driving can be expected to affect energy use and the environment. Part III argues that the way that the Environmental Protection Agency (EPA) has treated automated driving precursor technologies sets a troubling precedent for the agency's ability to fully engage with the difficult and necessary questions that automated driving poses in the future. Part IV explores the ways that state and local governments can both shape the development of automated driving technology in an environmentally protective direction, and have those efforts recognized by EPA.

I. AUTOMATED DRIVING OVERVIEW

Some automated driving features have already been developed and deployed into the market, mostly directed at

13 *See infra* Part II.0
14 *See infra* Part III.

improving passenger safety.[15] Thus, the federal auto safety regulator, the National Highway and Transportation Safety Administration (NHTSA), has taken the lead in devising federal automated driving policy to date.[16] NHTSA has already required new vehicles to have Electronic Stability Control, an automated safety feature that modulates braking and torque to prevent dangerous spinouts,[17] and has taken steps to prod the auto industry to adopt another automated braking technology to prevent forward collisions.[18]

NHTSA distinguishes between three related but distinct automated driving vehicle technologies. Crash avoidance technologies like Electronic Stability Control take control from the driver for limited emergency maneuvering to avoid an imminent

15 *See Crash Avoidance Technologies*, INSURANCE INST. FOR HIGHWAY SAFETY, http://www.iihs.org/iihs/topics/t/automation-and-crash-avoidance/topicoverview (last visited Jan. 29, 2017) ("Advanced technologies [that] assist the driver . . . to help avoid or mitigate a crash [] include front crash prevention, lane departure warning, blind spot detection, adaptive headlights and park assist and backover prevention. Advances also are being made in intelligent transportation systems that allow vehicles to communicate with one another or with road infrastructure to help avoid crashes.").

16 *See* NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., FEDERAL AUTOMATED VEHICLES POLICY (2016) [hereinafter 2016 NHTSA POLICY]; NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., DOT/NHTSA POLICY STATEMENT CONCERNING AUTOMATED VEHICLES (2016) (updating the preliminary policy, and characterizing policy regarding automated driving technology as primarily safety-oriented); NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., PRELIMINARY STATEMENT OF POLICY CONCERNING AUTOMATED VEHICLES (2013) [hereinafter 2013 NHTSA Policy] (announcing official automated vehicle policy). *But see* Jacob Ward, *Connected/Automated Vehicles (CAVs) and DOE*, U.S. DEP'T OF TRANSP. (Oct. 22, 2014), http://www.its.dot.gov/aeris/pdf/14_ConnectedAutomatedVehicles_DOE.pdf (including connected and automated vehicles in scope of DOE's Energy Efficiency and Renewable Energy program area and setting a research agenda).

17 *See* Federal Motor Vehicle Safety Standards: Electronic Stability Control Systems, 72 Fed. Reg. 17236, 17236, 17310, 17313 (Apr. 6, 2007).

18 NHTSA has not added Automated Emergency Braking regulatory requirements for new vehicles, but has taken other steps to bring about their widespread adoption. *See* New Car Assessment Program, 80 Fed. Reg. 78522 (Dec. 16, 2015) (proposing to give credit for Automated Emergency Braking for purposes of NHTSA's five star safety rating system); Press Release, Nat'l Highway Traffic Safety Admin., U.S. DOT and IIHS Announce Historic Commitment of 20 Automakers to Make Automatic Emergency Braking Standard on New Vehicles (Mar. 17, 2016), https://www.nhtsa.gov/press-releases/us-dot-and-iihs-announce-historic-commitment-20-automakers-make-automatic-emergency (announcing agreement brokered by NHTSA for large automakers to roll out automated braking).

hazard.[19] Connected vehicles use radio frequencies to communicate with other vehicles, infrastructure, or both.[20] Finally, NHTSA anticipates highly automated vehicles as a third emerging technology, distinct from the others, but relying heavily on their technological contributions.[21]

The White House and the Department of Transportation have announced ambitious plans to shape automated driving technology in coming years. In 2015, President Obama named advanced vehicles as one of the focuses of the "Strategy for American Innovation."[22] The announcement promised large federal investments in research, federal demonstration projects, additional connected vehicle technology requirements for new cars, and coordination of efforts to address liability, privacy and insurance issues.[23] In 2016, the White House announced a $40 million grant for a "Smart City Challenge," for which a city would be chosen to demonstrate automated and connected vehicles.[24]

In January 2016, the White House announced that its 2017 budget request would include $3.9 billion for automated vehicle

19 *See* Federal Motor Vehicle Safety Standards: Electronic Stability Control Systems, 72 Fed. Reg. 17236, 17243 (Apr. 6, 2007) (describing Electronic Stability Control systems); New Car Assessment Program, 80 Fed. Reg. 78522, 78565 (Dec. 16, 2015) (describing other emerging crash avoidance technologies).

20 Rudimentary vehicle-to-infrastructure (V2I) connected vehicle technology is already widespread in the form of radio tags allowing wireless payment of tolls. *See id.* at 78565; *see also* J. HARDING ET AL., VEHICLE-TO-VEHICLE COMMUNICATIONS: READINESS OF V2V TECHNOLOGY FOR APPLICATION 4 (2014) (discussing automated tolling). Some shared car networks also use radio communication and GPS to allow users to return cars by parking them at any space legal within a defined geographic area. *See* MATTHEW CUDDY ET AL., THE SMART/CONNECTED CITY AND ITS IMPLICATIONS FOR CONNECTED TRANSPORTATION 28–35 (2014) (discussing shared car networks like car2go which use wireless network technology). Future connected vehicle-to-vehicle (V2V) applications could help cars match speed, avoid collisions at actively managed intersections, automatically find parking, and otherwise improve efficiency of operation.

21 2016 NHTSA POLICY, *supra* note 16, at 3.

22 *See* NAT'L ECON. COUNCIL & OFFICE. OF SCI. AND TECH. POLICY, A STRATEGY FOR AMERICAN INNOVATION 92 (2015).

23 *See id.* at 92–93.

24 *See* Jeffrey Zients & John P. Holdren, *American Innovation in Autonomous and Connected Vehicles*, WHITE HOUSE (Dec. 7, 2015, 3:53 PM) www.whitehouse.gov/blog/2015/12/07/american-innovation-autonomous-and-connected-vehicles; *see also Smart City Challenge*, U.S. DEP'T OF TRANSP., https://www.transportation.gov/smartcity (last visited Jan. 29, 2017).

technology.[25] At the same time, the Department of Transportation updated its policy guidance, embracing automated driving, and taking a far more encouraging tone than it had in 2013.[26] In September 2016, the department released an ambitious national automated vehicle policy unequivocally embracing the goal of accelerating the introduction of highly automated vehicles.[27] However, the agency made only fleeting mention of energy or environmental benefits in a section devoted to responsibilities of state regulators.[28] Rather, NHTSA maintained its determination, established in its 2013 guidance, that "all the department's activities in the area of automated and connected vehicles will keep its life-saving mission as their focus."[29]

In its 2016 policy, NHTSA adopted the standardized definitions of levels of vehicle automation first proposed by SAE International:[30]

- At SAE Level 0, the human driver does everything;
- At SAE Level 1, an automated system on the vehicle can sometimes assist the human driver [with] conduct[ing] some parts of the driving task;
- At SAE Level 2, an automated system on the vehicle can actually conduct some parts of the driving task, while the human continues to monitor the driving environment and performs the rest of the driving task;
- At SAE Level 3, an automated system can both actually conduct some parts of the driving task and monitor the driving environment in some instances, but the human driver must be ready to take back control when the

25 *See* Ashley Halsey III, *White House Hopes to Shape National Policy on Driverless Cars*, WASH. POST (Jan. 14, 2016), https://www.washingtonpost.com/local/trafficandcommuting/white-house-hopes-to-shape-national-policy-on-driverlesscars/2016/01/14/46e3bd1e-ba4e-11e5-829c-26ffb874a18d_story.html?utm_term=.f99717cb899f.

26 *See* U.S. DEP'T OF TRANSP., DOT/NHTSA POLICY STATEMENT CONCERNING AUTOMATED VEHICLES (2016), http://www.nhtsa.gov/staticfiles/rulemaking/pdf/Autonomous-Vehicles-Policy-Update-2016.pdf; Cecilia Kang, *Self-Driving Cars Gain Powerful Ally: The Government*, N.Y. TIMES (Sept. 19, 2016), https://www.nytimes.com/2016/09/20/technology/self-driving-cars-guidelines.html (comparing the 2013 policy statement to the 2016 version).

27 *See* 2016 NHTSA POLICY, s*upra* note 16, at 6.

28 *See id.* at 44.

29 *See* 2016 NHTSA POLICY, *supra* note 16.

30 *See* 2016 NHTSA POLICY, s*upra* note 16, at 9; SAE INTERNATIONAL, J3016: TAXONOMY AND DEFINITIONS FOR TERMS RELATED TO ON-ROAD MOTOR VEHICLE AUTOMATED DRIVING SYSTEMS (2014).

automated system requests;

- At SAE Level 4, an automated system can conduct the driving task and monitor the driving environment, and the human need not take back control, but the automated system can operate only in certain environments and under certain conditions; and
- At SAE Level 5, the automated system can perform all driving tasks, under all conditions that a human driver could perform them.

Many of the most anticipated automated vehicle applications, such as networks of driverless taxis, would require Level 4 or 5 vehicles that could operate empty for short periods of time.[31] At least one firm is aggressively testing prototype vehicles that lack any steering mechanism for driver control.[32]

II. ENVIRONMENTAL IMPACTS OF AUTOMATED VEHICLES

While vehicle safety is undoubtedly important, governments should also fully consider the energy and environmental impacts of automated driving. The way that automated driving affects the environment will depend heavily on which of the many potential applications are adopted.[33] The changes automated driving will generate in car design, traveler behavior, and even land use and city design will all have dramatic environmental impacts. While even an individual automated vehicle can realize some efficiency gains, the greatest impacts emerge from network effects that come with more widespread adoption of highly automated vehicles.[34]

31 *See* Don MacKenzie, Zia Wadud & Paul Leiby, *A First Order Estimate of Energy Impacts of Automated Vehicles in the United States* 2–3, 11, 16 (Transp. Res. Board, Working Paper No. 14-2193, 2014); *see also* RAPHAEL BARCHAM, CLIMATE AND ENERGY IMPACTS OF AUTOMATED VEHICLES 6, 7, 18 (June 2014), https://www.arb.ca.gov/research/sustainable/automated_vehicles_climate_july2014_final1.pdf (last visited Feb. 1, 2017). These papers, and others cited *infra* projecting the environmental impact of automated driving predate the adoption of the five-level framework, and consider Level 4 vehicles to be fully automated.

32 *See Hands Off: The Future of Self Driving Cars*: *Hearing Before the S. Comm. on Commerce, Science and Technology*, 114th Cong. 3 (2016) (testimony of Dr. Chris Urmson, Director, Self Driving Cars, Google X), https://www.commerce.senate.gov/public/_cache/files/5c329011-bd9e-4140-b046-a595b4c89eb4/BEADFE023327834146FF4378228B8CC6.google-urmson-testimony-march152016.pdf; GOOGLE SELF DRIVING CAR PROJECT, https://www.google.com/selfdrivingcar/ (last visited Nov. 14, 2016).

33 *See* Ward, *supra* note 16, at 6; BARCHAM, *supra* note 31, at 16–17.

34 *See* Zia Wadud et al., *Help or Hindrance? The Travel, Energy and Carbon Impacts of Highly Automated Vehicles*, 86 TRANSP. RES. PART A 1, 13

However, automated driving may also lead to a greater number of car trips and vehicle miles traveled.[35] Thus, it is an open question whether automated driving will lead to an overall increase or decrease in emissions.

A. *Trip Efficiency and Platooning*

Automated driving could make individual trips more fuel efficient by eliminating unnecessary acceleration and deceleration.[36] Vehicles with data connections to infrastructure, other vehicles, and traffic information could optimize routing to avoid congested roadways,[37] or even time their approaches to intersections to avoid needing to stop at red lights.[38] Reduced idling, stopping, and starting of an individual vehicle could not

(2016) (showing very little overall energy impact if only up to Level 2 automated vehicles are widely adopted).

35 *See infra* Part II.

36 *See* Austin Brown, Jeffrey Gonder & Brittany Repac, *An Analysis of Possible Energy Impacts of Automated Vehicles*, *in* ROAD VEHICLE AUTOMATION 140–41 (Gereon Meyer & Sven Beiker eds., 2014); MacKenzie et al., *supra* note 31, at 5; NATIONAL RESEARCH COUNCIL, TRANSITIONS TO ALTERNATIVE VEHICLES AND FUELS 144 (2013). Some "eco-driving" technologies that provide feedback to drivers with the goal of improving fuel efficiency are already being marketed. Optimizing an automated vehicle for trip efficiency would be an evolution of the same concept, though presumably more effective, as it would not rely on a driver to respond to alerts. *See, e.g.*, *SmartDrive Fuel*, SMARTDRIVE (2015), https://www.smartdrive.net/smartdrivefuel.aspx (consumer real-time driver feedback to improve fuel efficiency); *Improved Driver Behavior*, TOMTOM TELEMATICS (2016), http://business.tomtom.com/en_us/fleet-management/improved-driver-behavior (fleetwide commercial fuel efficiency management for freight operators); Daniel Gross, *The Fuel-Efficient Driver*, SLATE.COM (May 7, 2015), http://www.slate.com/articles/business/the_juice/2015/05/greenroad_bus_and_truck_technology_an_ingenious_way_to_help_gas_guzzlers.html.

37 *See* Brown et al., *supra* note 36, at 142; Matthew Barth, Kanok Boriboonsomsin & Guoyuan Wu, *Vehicle Automation and Its Potential Impacts on Energy and Emissions*, *in* ROAD VEHICLE AUTOMATION 107 (Gereon Meyer & Sven Beiker eds., 2014); Jeffrey Gonder, Eric Wood & Sai Rajagopalan, NAT'L RENEWABLE ENERGY LAB., NREL/CP-5400-60960, CONNECTIVITY-ENHANCED ROUTE SELECTION AND ADAPTIVE CONTROL FOR THE CHEVROLET VOLT (2014) (modeling a 5% reduction in energy from efficient routing without even incorporating real-time traffic information); *cf.* Kathryn Miller et al., U.S. DEP'T OF TRANSP., FHWA-JPO-11-139, APPLICATIONS FOR THE ENVIRONMENT: REAL-TIME INFORMATION SYNTHESIS (AERIS): APPLICATIONS STATE OF THE PRACTICE ASSESSMENT REPORT 26–28 (2011) (describing eco-routing applications available for existing driver-operated navigation systems).

38 *See* Yunjie Zhao et al., *A Partial Reality Experimental System for Human-in-the-Loop Testing of Connected and Automated Vehicle Applications: Development, Validation and Applications*, *in* ROAD VEHICLE AUTOMATION 192 (Gereon Meyer & Sven Beiker eds., 2014).

only reduce the emissions of the individual vehicle, but also improve the efficiency of other cars on the roadway, automated and otherwise, by reducing congestion. Tests have demonstrated great potential for efficiencies through "platooning" columns of vehicles closer together than would be safe for a human driver at highway speeds, in order to take advantage of aerodynamic effects that reduce drag.[39]

With widespread adoption of fully automated vehicles, dramatically more efficient utilization of road infrastructure becomes possible.[40] Reduced distance between vehicles, both laterally and front to back, could greatly increase the capacity of existing roads and delay or forestall the need for new construction.[41] Road lanes could reverse direction in real time to accommodate peak traffic throughout the day.[42] Simulations have demonstrated how precisely spaced and managed vehicle streams could flow simultaneously through intersections in all directions without the need for traffic signals.[43] Ultimately, this technology

39 Platooning would take advantage of connected vehicles, as well as adaptive cruise control and lane-keeping functions. One field test of platooning vehicles found fuel efficiency improvements of 10–14% for following vehicles, and 4.3% for lead vehicles, due to reduced drag. *See* Xiao-Yun Lu & Steven E. Shladover, *Automated Truck Platoon Control and Field Test*, *in* ROAD VEHICLE AUTOMATION 247, 258 (Gereon Meyer & Sven Beiker eds., 2014); *Commission Final Report on SAfe Road TRains for the Environment*, 7 Grant No. 233683 (2011) (showing similar fuel efficiency improvements); Brown et al., *supra* note 36, at 140; MacKenzie et al., *supra* note 31, at 6; BARCHAM, *supra* note 31, at 16.

40 *See* Brown et al., *supra* note 36, at 143; BARCHAM, *supra* note 31, at 17; ENO CTR. FOR TRANSP., PREPARING A NATION FOR AUTONOMOUS VEHICLES 5 (2013); *see also* William R. Morrow III et al., *Key Factors Influencing Autonomous Vehicles' Energy and Environmental Outcome*, *in* ROAD VEHICLE AUTOMATION 127, 132–33 (Gereon Meyer & Sven Beiker eds., 2014).

41 *See* GARY SILBERG & RICHARD WALLACE, CTR. FOR AUTO. RESEARCH, SELF-DRIVING CARS: THE NEXT REVOLUTION 26 (2012); Adriano Alessandrini et al., *CityMobil2: Challenges and Opportunities of Fully Automated Mobility*, *in* ROAD VEHICLE AUTOMATION 171–72 (Gereon Meyer & Sven Beiker eds., 2014).

42 *See* Morrow et al., *supra* note 40, at 132. Reversible lanes are already used in many cities, but a system optimized for automated vehicles could adapt and assign lanes in real time. *See id.*

43 *See generally, e.g.*, Kurt Dresner & Peter Stone, *A Multiagent Approach to Autonomous Intersection Management*, 31 J. OF ARTIFICIAL INTELLIGENCE RES. 591, 611 (2008); DUSTIN CARLINO ET AL., AUCTION-BASED AUTONOMOUS INTERSECTION MANAGEMENT, PROCEEDINGS OF THE 16TH IEEE INTELLIGENT TRANSPORTATION SYSTEMS CONFERENCE (2013), http://www.cs.utexas.edu/~aim/papers/ITSC13-dcarlino.pdf; Chairit Wuthishuwong et al., *Safe Trajectory Planning for Autonomous Intersection Management by Using Vehicle to Infrastructure Communication*, 33 EURASIP J. ON WIRELESS COMM. AND

could be used to efficiently distribute traffic across available road capacity to reduce travel time and emissions associated with congestion.

Optimizing the street grid for automated driving, however, could have negative effects on other road users, unless carefully designed to ensure continued accessibility. An intersection or traffic corridor designed to optimize fully automated driving by eliminating traffic signals, for example, could be difficult or intimidating for cyclists, motorcyclists, and pedestrians.[44] Travelers who currently use alternate methods may flee into automobiles, increasing total vehicle miles traveled. On the other hand, an automated driving system that reduced the need for parking and travel lanes in city centers could leave space for bike lanes, cycle tracks, improved pedestrian facilities, and transit lanes.[45]

At the end of trips, assisted parking could reduce time spent on the road. Some estimates attribute an average of 30 percent of traffic in central business districts to circling drivers "cruising" for parking.[46] Level 4 automated vehicles could drop passengers at their destinations and park themselves further afield.[47] In addition to reducing total travel distance by eliminating cruising, this would reduce congestion on the crowded streets near popular destinations, where parking is in highest demand.

B. *Collision Avoidance*

A major expected benefit of automated driving is improved passenger safety.[48] Preventing fatalities and injuries is naturally the focus of safety regulators and automated vehicle manufacturers. In

NETWORKING 1 (2015).

44 *See* TODD LITMAN, VICTORIA TRANSP. POLICY INSTITUTE, AUTONOMOUS VEHICLE IMPLEMENTATION PREDICTIONS: IMPLICATIONS FOR TRANSPORT PLANNING 17–18 (2015).

45 *See* SILBERG & WALLACE, *supra* note 41, at 26 (discussing the potential for repurposing existing roadways to bicycle or pedestrian facilities).

46 *See* Donald C. Shoup, *Cruising for Parking*, 13 TRANSPORT POLICY 479, 480 (2006); *see also* Brown et al., *supra* note 36, at 145–46; JAMES M. ANDERSON ET AL., RAND CORP., AUTONOMOUS VEHICLE TECHNOLOGY: A GUIDE FOR POLICYMAKERS 18 (2014); Barth et al., *supra* note 37, at 111.

47 *See, e.g.*, Yasuhiro Okumura, *Activities, Findings and Perspectives in the Field of Road Vehicle Automation in Japan*, *in* ROAD VEHICLE AUTOMATION 37, 40 (Gereon Meyer & Sven Beiker eds., 2014) (Honda demonstrated automated valet parking systems at the ITS World Congress in Tokyo in 2013).

48 *See* SILBERG & WALLACE, *supra* note 41, at 7.

addition to NHTSA's currently required "electronic stability control,"[49] and automated braking features that may soon be required,[50] manufacturers have equipped vehicles with automated lane keeping, driver fatigue warnings, and other automated safety features.[51] But collision avoidance would also contribute to trip efficiency and emissions reductions. Collisions in the United States result in lengthy traffic delays that cost an estimated $28 billion per year and generate additional emissions.[52] Eliminating the risk of collisions would also enable auto manufacturers to build lighter, more aerodynamic, and much more fuel-efficient vehicles.[53]

C. *Network Effects*

With widespread adoption of vehicles at autonomy Levels 4 and 5 comes the possibility of truly transformative applications. Perhaps the most widely discussed is the potential for shared vehicle networks available on request.[54] Such a network has already begun testing in Pittsburgh, where Uber, a transportation network company (TNC), has begun servicing some ride requests with automated vehicles, albeit with constant supervision of the company's technicians.[55] In the future, by eliminating the need for

49 *See* Federal Motor Vehicle Safety Standards, *supra* note 17.

50 *See* New Car Assessment Program, *supra* note 18, at 78523; U.S. DOT and IIHS Announce Historic Commitment Of 20 Automakers To Make Automatic Emergency Braking Standard On New Vehicles, *supra* note 18.

51 *See* ENO CTR. FOR TRANSP., *supra* note 40, at 2; Paul Gao, Russell Hensley & Andreas Zielke, *A Road Map To The Future For The Auto Industry*, 10 MCKINSEY QUARTERLY 43, 46–47 (2014), KALRA, *supra* note 11, at 46–47 (recommending that NHTSA accelerate rulemaking to require "mature technologies" like lane departure and collision warnings and driver-fatigue monitoring).

52 *See* U.S. DEP'T OF TRANSP., DOT HS 812 013, THE ECONOMIC AND SOCIETAL IMPACT OF MOTOR VEHICLE CRASHES, 90–109 (2014) (detailing estimated cost of emissions externalities per vehicle collision).

53 *See* Brown et al., *supra* note 36, at 144–45; MacKenzie et al., *supra* note 31, at 7–8, *cf*. Lawrence D. Burns, William C. Jordan & Bonnie A. Scarborough, EARTH INST., COLUMBIA UNIV., TRANSFORMING PERSONAL MOBILITY 13–14 (2013) (modeling the energy savings from dispatching vehicles tailored to the trip length and number of passengers, designed for efficiency rather than crashworthiness).

54 ANDERSON ET AL., *supra* note 46, at 18.

55 Ed Blazina, *Uber Rolls out Self-Driving Vehicles to Public*, PITTSBURGH POST-GAZETTE (Sept. 14, 2016), http://www.post-gazette.com/news/transportation/2016/09/14/Uber-rolling-out-self-driving-vehicles-to-the-public-today-Pittsburgh/stories/201609140107.

drivers, automated shared vehicles could provide cheaper and more reliable on-demand transportation, even in smaller markets where demand has been too low to support full time networks of taxi or TNC drivers.[56] This could reduce the need for private vehicle ownership.[57] On-demand vehicles engaged for single trips could be "right-sized," with smaller, lower-emissions vehicles used for most trips, and larger vehicles used only when needed.[58]

An average vehicle is currently parked 95 percent of the time.[59] The need to provide parking for vehicles leads cities to commit large amounts of prime downtown real estate to vehicle storage.[60] Replacing private vehicles with on-demand automated vehicles could allow repurposing of both off-street parking and street space in valuable city centers to more beneficial uses.[61] If automated driving results in denser city centers, it could actually reduce the number of trips taken by car, as services and destinations would be located closer together and walking routes would become more manageable and appealing. Because the automated fleet would be indifferent as to whether its "home base" was in the city center, vehicles could be stored in peripheral areas when not in use.[62] To the extent that individuals did continue to

56 *See* Brishen Rogers, *The Social Costs of Uber*, 82 U. CHI. L. REV. DIALOGUE 85, 88–89 (2015) (describing the high search costs and other shortcomings of taxi services relative to mobile app enabled carshare services); LITMAN, *supra* note 44, at 6; Burns, Jordan & Scarborough, *supra* note 53, at 15 (modeling the potential for a shared automated vehicle network in Ann Arbor, Mich.); *cf.* Rachel Levin, *Uber Rolls into Martha's Vineyard and Finds Some Resistance*, N.Y. TIMES (Sept. 1, 2015), https://www.nytimes.com/2015/09/06/travel/uber-marthas-vineyard.html (describing Uber drivers' challenges finding viable levels of business in rural towns along Cape Cod, Massachusetts).

57 *See* Brown et al., *supra* note 36, at 143, 149; *cf.* Gao, Hensley & Zielke, *supra* note 51, at 11; MacKenzie et al., *supra* note 31, at 11.

58 *See* Brown et al., *supra* note 36, at 145; Geoff Burmeister et al., Automated Vehicles for a Sustainable City 12–13 (Dec. 2014) (unpublished comment); Morrow et al., *supra* note 40, at 130–31; MacKenzie et al., *supra* note 31, at 8.

59 ANDERSON ET AL., *supra* note 46, at 26.

60 *See, e.g.*, DONALD SHOUP, THE HIGH COST OF FREE PARKING 589–91 (2d ed. 2011).

61 *See* BARCHAM, *supra* note 31, at 18; ANDERSON ET AL., *supra* note 46, at 26; *cf. also, generally,* Shoup, *supra* note 46 (describing externalities from each private vehicle, permitting the inference that, as each shared car would replace multiple private vehicles, benefits would be compounded).

62 Of course, the fact that the vehicles would still need to be stored somewhere could lead to environmental justice issues. Economically and environmentally disadvantaged, and therefore inexpensive areas would be likely

own private vehicles, they could potentially make these vehicles available to the public when not in use in exchange for a share of the fare.[63]

High level automated driving could also help overcome barriers to the adoption of electric vehicles. The need to charge electric vehicles and the length of time necessary to do so are inconveniences, as access to charging stations is still limited in many cities and may not be available near a commuter's workplace. However, a vehicle in a shared automated network would be indifferent to being taken out of service for charging. Therefore, it could transport passengers until its battery ran low and return to a peripheral parking facility to connect to a power source.[64] Furthermore, a shared automated vehicle could better justify the higher up-front cost for an electric vehicle, as its higher utilization rate would accelerate the payback period from its much lower fueling costs.[65]

D. *Traveler Behavioral Responses*

Some applications of automated driving would generate environmental harms—primarily, the almost certain increase in total vehicle miles traveled that would accompany its widespread use. Automated driving could improve overall mobility by reducing the cost of on-demand trips, and by expanding safe travel

to attract space-intensive land uses like bulk vehicle storage. If parking were consolidated, the large number of trips by empty vehicles could disrupt neighborhoods, and would generate little localized economic activity. *Cf.* South Bronx Unite v. NYC Indus. Development Agency, 2013 WL 6840438 (N.Y. Sup. Ct. Bronx Div. 2014) (community organization brought suit against the construction of a large grocery distribution warehouse, on the grounds that the noise and air quality impact of added vehicle trips would burden the already disadvantaged community.).

63 TNCs already allow private vehicle owners to use their cars as revenue generating assets, but currently, they must also provide their labor. *See* Eric Goldwyn, *Will Uber Destroy the Driving Profession?*, NEW YORKER (June 23, 2014) (discussing the mix of "experienced professionals and part-timers who fill in the cheaper end of the [driving] market," and Uber's attempt to use technology to "transform the casual driver into a professional").

64 *See* Brown et al., *supra* note 36, at 146; ANDERSON ET AL., *supra* note 46, at 34–35; Kevin Spieser et al., *Toward a Systematic Approach to the Design and Evaluation of Automated Mobility-on-Demand Systems: A Case Study in Singapore*, MASS. INST. TECH. OPEN ACCESS ARTICLE 1, 2 (2015), http://hdl.handle.net/1721.1/82904; MacKenzie et al., *supra* note 31, at 12.

65 *See* Brown et al., *supra* note 36, at 146; MacKenzie et al., *supra* note 31, at 12.

options for those who are too young, disabled, or intoxicated, or otherwise unable to drive.[66] Underserved populations who take few trips now, including those limited by economic constraints, will likely travel more if costs are eased by automated driving.[67] An overall increase in vehicle miles traveled (VMT) could lead to more energy use and emissions.[68] While other effects described above would have the effect of reducing the impact of each mile of travel, these efficiencies could be negated if they are accompanied by a substantial increase in VMT.

To the extent that shared automated vehicles reduce the cost of a car trip, they will compete not only with privately owned cars, but also with even more environmentally desirable transportation methods like mass transit.[69] Diverting passengers from transit into single occupancy vehicles would both increase emissions from additional congestion and undermine more sustainable alternatives. This effect must be a part of any analysis of the environmental impact of automated driving. Nevertheless, there are also potential synergies that could allow automated vehicles to make transit more effective. Automated vehicles themselves could be used for multiple passengers at once, with automated matching of travelers with similar destinations.[70] Automated shuttles could also help solve the "first and last mile" problem to make mass transit more accessible in areas of less dense development, reducing the need for currently oversubscribed park-and-ride lots and facilitating more efficient development of prime areas surrounding transit

66 *See generally* Bryant Walker Smith, *Managing Autonomous Transportation Demand*, 52 SANTA CLARA L. REV. 1401 (2012); *see* Brown et al., *supra* note 36, at 142, 150; ANDERSON ET AL., *supra* note 46, at 37; Gao, Hensely & Zielke, *supra* note 51, at 9–10; MacKenzie et al., *supra* note 31, at 10–11.

67 *See* Brown et al., *supra* note 36, at 149.

68 *See* ANDERSON ET AL., *supra* note 46, at 18.

69 *See* U.S. DEP'T OF TRANSP., BEYOND TRAFFIC 2045, TRENDS AND CHOICES 102–03 (2015); *cf*. Rayle et al., *supra* note 55, at 13, 15–18 (analyzing the extent to which inexpensive human-driven TNC vehicles already compete with public transit in some scenarios, while noting that in others, they can complement mass transit).

70 *See* Brown et al., *supra* note 36, at 149; Daniel Fagnant & Kara M. Kockelman, *The Travel and Environmental Implications of Shared Autonomous Vehicles, Using Agent-Based Model Scenarios*, 40 TRANSP. RESEARCH PT. C 1, 3 (2014); *cf. generally* Paolo Santi et al., *Quantifying The Benefits of Vehicle Pooling with Shareability Networks*, 111 PROCEEDINGS OF THE NAT'L ACADEMIES OF SCI. 13290, 13290 (2014) (considering the benefits of real-time carpooling in conventional vehicles.).

stations.[71] And, of course, effective mass transit represents a comparatively small share of trips in the United States, so this impact will be most relevant in the few large cities where mass transit is currently widely utilized.[72]

Automated vehicles could either contribute to sprawl, or allow denser, more walkable development of city centers, depending on policy choices. City center land currently devoted to parking could be developed, providing more residential opportunities and services within walkable communities.[73] However, commuters who currently must spend their commuting time operating their vehicles could regain that time for work or leisure during their commutes.[74] These changes could encourage sprawl by reducing or eliminating some of the disadvantages of residing in an area distant from employment.[75]

E. *Modeling of Net Energy Impacts From Automated Driving*

Multiple scholars have attempted to model the complex overall energy and environmental impact of automated driving. The most significant impacts on emissions will come with widespread adoption, and thus are difficult to predict with certainty. Different potential technological development pathways would result in very different energy impacts. Under a model

71 *See* Brown et al., *supra* note 36, at 150; *cf*. Bryant Walker Smith, *Driverless Carts Are Coming Sooner than Driverless Cars*, CTR. FOR INTERNET AND SOC'Y (Sept. 30, 2013), http://cyberlaw.stanford.edu/blog/2013/09/driverless-carts-are-coming-sooner-driverless-cars (arguing that transit feeder routes may be served by automated "carts" which could make mass transit more effective by solving the last-mile problem).

72 While transit is extremely important to commuters in the largest American cities, in most cities it is not a major factor. *See* AM. ASSOC. OF STATE HWY. AND TRANSP. OFFICIALS, COMMUTING IN AMERICA 2013: BRIEF 13 TRANSIT COMMUTING 10 (2015) (showing only five American cities having a greater than 10% share of commutes served by transit, with less than 5% mode share in the overwhelming majority of cities).

73 *See supra* notes 59–61 and accompanying text.

74 *See* SILBERG & WALLACE, *supra* note 41, at 29; Steven E. Underwood, *Disruptive Innovation on the Path to Sustainable Mobility: Creating a Roadmap for Road Transportation in the United States*, *in* ROAD VEHICLE AUTOMATION 157, 167 (Gereon Meyer & Sven Beiker eds., 2014); Spieser et al., *supra* note 64, at 12–13 (discussing the monetary value of time spent in automobiles).

75 *See* BARCHAM, *supra* note 31, at 18; Morrow et al., *supra* note 40, at 133–35; ANDERSON ET AL., *supra* note 46, at 39. *But see* U.S. DEP'T OF TRANSP., *supra* note 69, at 106 (arguing that effect on sprawl is uncertain and will not be known until automated vehicles are widely available).

produced for the National Renewable Energy Laboratory (NREL), researchers predicted that automated driving could result in energy savings of up to 90 percent if all positive synergies were realized and there were no rebound effects,[76] but that if the equivalent of the existing fleet were merely automated without such synergies, the resulting increase in VMT could increase vehicle energy use by 173 percent.[77]

Researchers from the Oak Ridge National Laboratory modeled energy implications of automated driving for the Transportation Research Board, and found that environmental impacts will depend heavily on whether vehicles are optimized for speed or for efficiency;[78] whether network effects result in system-wide changes like shared vehicle systems and electrification; and whether and how much passengers increase their VMT as driving becomes cheaper and more pleasant.[79] The study concluded that most of the largest impacts would come from automation at Levels 4 and 5, and that the technology can result in wildly differing energy impacts depending on implementation.[80] In the scenario assuming substantial impacts in all areas, environmental efficiencies were nearly matched by increased VMT and highway speed, resulting in little net energy effect.[81]

Two University of Texas researchers modeled potential emissions and energy reductions from a shared automated driving service, and projected that, without considering vehicle electrification or rebound impacts, shared automated vehicles would result in a 5.6 percent reduction in greenhouse gas emissions, with even greater decreases in other pollutants.[82] The modeled benefits of efficient driving, reduced trip-start emissions, and higher fleet turnover (with new, more efficient vehicles used for a greater share of trips) outweighed the impact of increased VMT from cars operating empty.[83] Some urbanists and

76 *See* Brown et al., *supra* note 36, at 147.

77 *See id*. at 147–48 (Relatively minor gains from more efficient acceleration and deceleration could be overcome by increase in vehicle miles traveled.).

78 *See* MacKenzie et al., *supra* note 31, at 6, 14 (contrasting development pathways where governments respond to automation by increasing traffic speed to a pathway emphasizing energy and land use efficiency).

79 *See id.* at 3–4.

80 *See id.* at 14.

81 *See id.* at 14.

82 *See* Fagnant & Kockelman, *supra* note 70, at 15.

83 *See id.* at 20.

transportation planners have criticized the more optimistic scenarios, suggesting that even if platooning, shared automated vehicles, and reductions in parking space were feasible in theory, many of the network effects are unlikely given the fact that transportation planners will primarily have to address the needs of conventional vehicles for the foreseeable future.[84]

In 2014, the California Air Resources Board (CARB) commissioned a review of research on climate and energy impacts of automated driving.[85] The report noted the multiple potential pathways for the development of vehicle automation, and their differing impacts on the environment. In order to facilitate the most sustainable development pathway, the report recommended that CARB fully engage in shaping California's automated vehicle policy, heretofore set by a working group of state transportation agencies.[86] The report also recommends that CARB assist Metropolitan Planning Organizations (MPOs) in modeling the impact of automated vehicles, and managing existing clean vehicle incentive programs to reflect any proven benefits.[87] Finally, the report suggested that CARB attempt to promote, to the extent possible, a shared model for automated vehicles, to realize system-wide benefits and compensate for possible increased VMT.[88]

F. *Research and Policy Implications*

If the models of automated driving environmental impacts agree on anything, it is that much remains to be done in determining what consequences this technology will have for the environment. Energy impacts will depend on adoption timeframe, vehicle design, influence on vehicle electrification, and network effects. While uncertainty remains high, the universe of potential benefits and costs has begun to take shape, and researchers are working to refine their assumptions to provide clearer predictions.[89]

84 *See, e.g.*, LITMAN, *supra* note 44, at 16–17.

85 *See generally* BARCHAM, *supra* note 31.

86 *See id.* at 25–27.

87 *See id.*

88 *See id.*

89 *See generally*, *e.g.*, Jeffrey Gonder, Presentation at UMTRI Workshop on Energy and Environmental Implications of Automated Transportation: Energy/Environmental Impacts of Connectivity and Automation on Vehicle Operation (Apr. 23, 2014), http://umtri.umich.edu/content/2014.EnergyWS.Gon

Individual vehicle effects traceable to each vehicle, or "inside the wheelbase" effects, such as optimized acceleration and deceleration, are the easiest to quantify.[90] More indirect "outside the wheelbase" effects become more difficult to measure the further they are removed from an individual vehicle. Environmental effects of some network applications, like vehicle platooning, can be directly measured under experimental conditions.[91] However, emissions impacts from other effects, like VMT rebound, land use changes, impact on vehicle electrification, and new ownership models like car-share networks are far more uncertain. In order to determine the environmental impacts of such applications, policymakers will need to fully engage with sophisticated traffic modeling, GPS and other dataset analysis, and other intelligence tools that can reduce, but not fully eliminate uncertainty.[92]

Nevertheless, these difficult-to-quantify network effects are simultaneously the most potentially beneficial and threatening to the environment.[93] These also may be the applications for which government policy and incentives are the most important. Network effects that rely on connected vehicles require federal participation in allocating radio spectrum and setting standards for communication between vehicles.[94] Real-time lane direction allocation based on traffic demand would require state and local infrastructure investments and legislative changes. Changes in urban land use and regulation of shared automated vehicle networks may also require adjustments to local regulation of street

der.pdf (discussing work to refine models, define scenarios and bring together datasets to support analysis).

90 *See* MacKenzie et al., *supra* note 31, at 14 (demonstrating broad ranges of potential impacts from network effects, with more certain, but less significant impacts from individual vehicle effects).

91 *See supra* note 39 and accompanying text.

92 *Cf.* Daimler Comment, *infra* note 117, at A-13 (demonstrating the sort of literature review that was deemed insufficient to justify regulatory benefits for automated driving technology); 2017 Mobile Source Standards, *infra* note 100, at 62736 ("[D]epending on the level of benefit, the amount of resulting credit could be minimal compared [to] the effort to generate the necessary, supporting data, and manufacturers should consider this before undertaking this process.").

93 *See* MacKenzie et al., *supra* note 31, at 14–15 (predicting relatively minor energy impacts unless vehicle automation advances to a high level, permitting changes in vehicle ownership models).

94 *See Connected Vehicle Research in the United States*, U.S. DEP'T OF TRANSP. (Oct. 27, 2015), http://www.its.dot.gov/connected_vehicle/connected_vehicle_research.htm.

space, zoning, parking, and taxis. Network effects that rely on a critical mass of automated vehicles may eventually require government incentives for automated vehicle acquisition or retrofit, or even requirements that new vehicles be equipped with automated driving features.

While the Department of Transportation has made clear its intention to require automated safety features, it has regarded energy and environmental applications as outside of its jurisdiction, saying only that other authorities should consider them.[95] In order to realize the benefits and manage the costs of emerging automated vehicle technology, policymakers must play a central role in ensuring that environmental laws and regulations, not just consumer protection and transportation laws, reflect the impacts of automated vehicles. Where appropriate, environmental regulators must provide incentives and restrictions to ensure that technology develops to maximize net benefits, while managing any distributional consequences.

III. CLEAN AIR REGULATION OF AUTOMATED VEHICLES

Federal, state, and local governments play complementary but distinct roles in the regulation of the environmental impacts of motor vehicles. The Environmental Protection Agency (EPA), under the Clean Air Act, and the U.S. Department of Transportation (DOT), under the Energy Policy and Conservation Act, set fuel efficiency and emissions standards for cars and trucks. States and localities regulate the registration, licensing, and driving of motor vehicles, and design and build transportation infrastructure. However, only some of the environmental impacts of automated vehicles can be captured by the existing regulatory regime. For basic automated technologies already available on the market, federal regulators have chosen to sharply limit the extent to which emissions impacts of automated technology can be counted as a part of Clean Air Act compliance.

A. *Clean Air Act Title II Motor Vehicle Emissions Standards*

Title II of the Clean Air Act requires EPA to set standards for mobile sources to control emissions that endanger human health or welfare, such as carbon monoxide, ozone precursors, and

95 *See* 2016 NHTSA POLICY, *supra* note 16, at 44.

particulate matter.[96] Title II standards also include in-use regulations,[97] such as limits on how frequently manufacturers may require vehicle owners to maintain their vehicles.[98] Since 2009, EPA has also been responsible for greenhouse gas emissions from mobile sources,[99] which it has addressed by cooperating with DOT to harmonize EPA greenhouse gas emission standards with DOT's fuel economy standards.[100] In 2012, EPA and DOT jointly promulgated greenhouse gas and fuel efficiency standards for vehicles, set at a fleetwide average of 163 grams of carbon dioxide (CO_2) per mile (equivalent to 54.5 miles per gallon, if the standards were met solely through improving fuel efficiency.)[101]

1. *"Regulatory Incentives" for "Game-Changing" Vehicle Technology*

In its rule establishing greenhouse gas emissions standards for the 2017–2025 model years, EPA provided special incentives for "game-changing" low emissions vehicles that credited these vehicles with greater emissions reductions than they actually achieved.[102] For electric, plug-in hybrid, and fuel cell vehicles, EPA used a multiplier to count each vehicle more than once in calculating a manufacturer's fleetwide average, so that manufacturers could functionally increase their emissions allowances by marketing these vehicles.[103] In addition, EPA counts up to 600,000 advanced technology vehicles per manufacturer as emitting 0 grams of CO_2 per mile, rather than requiring them to determine the upstream emissions associated

96 *See* 42 U.S.C. § 7521(a).
97 *See* 42 U.S.C. § 7541.
98 *See* 42 U.S.C. § 7541(c)(3)(A); *see also* Motor & Equip. Mfrs. Ass'n, Inc. v. EPA, 627 F.2d 1095, 1103, 1107 (D.C. Cir. 1979).
99 *See* Massachusetts v. EPA, 549 U.S. 497, 531–33 (2007) (holding that EPA must regulate greenhouse gas emissions from mobile sources if they endanger health and welfare); Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496 (Dec. 15, 2009) (finding that greenhouse gases from mobile sources do, in fact, cause an endangerment, and thus must be regulated).
100 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) [hereinafter 2017 Mobile Source Standards].
101 *See id.* at 62,627.
102 *See id.* at 62,650–51.
103 *See id.*

with the electricity or alternative fuel they use.[104]

EPA's treatment of Compressed Natural Gas (CNG) vehicles is particularly notable. The agency provides a bonus to compressed natural gas vehicles, not because CNG itself is a "game-changing" technology, but because the development of CNG infrastructure could "indirectly support future commercialization of hydrogen [Fuel Cell Vehicles], which are a potential game-changing greenhouse gas (GHG) emissions technology."[105] This regulatory bonus for a favorable, but not "game-changing" technology on the basis that it may accelerate an even more promising approach in the future finds a potential parallel in automated vehicles. Researchers have identified one potential benefit of automated vehicles as the synergies with vehicle electrification.[106] Even if automated features on their own are not "game-changing," EPA's treatment of CNG suggests that if automated vehicles have a large effect on the deployment of electrification infrastructure, that effect by itself could justify a regulatory bonus.

EPA's ability to alter the numbers used in calculating compliance, such that a vehicle's emissions for compliance purposes are not its actual tailpipe emissions but a supplied regulatory value, demonstrates EPA's belief in its broad statutory flexibility to use emissions calculations to incentivize the adoption of new technologies. This authority would allow EPA to give credit for any benefits of automated vehicle technology in a future rulemaking should the agency determine that automated technologies are "potential game-changers."[107] The agency could also use the promise of such an incentive to help ensure that automated technologies are introduced in an environmentally beneficial manner. Existing multipliers in the rule for electric vehicles mean that, to the extent automated vehicles hasten the adoption of electric vehicles and electric vehicle charging infrastructure,[108] such vehicles would already receive some incentives under existing regulations.

104 *See id.* at 62,810–11.

105 *See id.* at 62,816.

106 *See supra* notes 64–65 and accompanying text.

107 *See* 2017 Mobile Source Standards, *supra* note 100, at 62,652 (describing incentive credits granted for the use of "game-changing" hybrid truck technology).

108 *See supra* notes 64–65 and accompanying text.

2. *Off-Cycle Credits for Title II Compliance*

EPA sets emissions standards for motor vehicles by testing the vehicles' emissions using a two-cycle (highway driving and city driving) analysis.[109] However, EPA recognizes that the benefits of some efficiency features are not reflected in this relatively limited test.[110] Manufacturers can earn "off-cycle" credit for advanced features like active transmission warm-up, waste heat recovery, and high efficiency exterior lighting, if they can demonstrate that the regular two-cycle test inadequately reflects the features' contributions to emissions reduction.[111]

In the rule for model years 2012–2016, auto manufacturers were required to submit data and seek credit for off-cycle technologies on a case-by-case basis.[112] However, in the rule for model years 2017–2025, EPA provided a menu with conservative default values for some popular off-cycle technologies, while providing an opportunity for case-by-case demonstration to result in additional credits for unlisted technologies.[113]

Off-cycle credits require a rigorous accounting of features' impacts on emissions.[114] Unlike bonuses for "game changing" electric and clean fuel vehicles, which incentivize market adoption with credit beyond vehicles' actual performance,[115] off-cycle credits are intended to ensure that vehicles' actual performance is reflected in manufacturers' compliance formula.[116] For the 2017 model year rule, EPA refused to grant off-cycle credit for early automated driving technologies, and explained its refusal in ways

109 *See* 2017 Mobile Source Standards, *supra* note 100, at 62,674.

110 *See* Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule, 75 Fed. Reg. 25,324, 25438 (May 7, 2010) [hereinafter 2012 Mobile Source Standards] (establishing off-cycle credits for efficiency features "for which the CO_2 reduction benefits are not significantly captured over the 2-cycle test procedure used to determine compliance with the fleet average standards").

111 *See* 2017 Mobile Source Standards, *supra* note 100, at 62,737.

112 *See* 2012 Mobile Source Standards, *supra* note 110, at 25,438.

113 *See* 2017 Mobile Source Standards, *supra* note 100, at 62,650.

114 *See* 40 C.F.R. §§ 86.1869-12(c) to (d) (establishing testing procedures for demonstrating off-cycle credits).

115 *See* 2017 Mobile Source Standards, *supra* note 100, at 62,650 (describing incentive multipliers as "temporary regulatory incentives to promote advanced vehicle technologies").

116 *See* 40 C.F.R. § 86.1869-12(a) ("technologies must have a measurable, demonstrable, and verifiable real-world CO_2 reduction that occurs outside the conditions of the Federal Test Procedure and the Highway Fuel Economy Test").

that could prevent off-cycle credit from being used to recognize future automated vehicle benefits. Furthermore, judicial treatment of similar agency actions in the past may leave the agency's reasoning legally vulnerable.

a. *Crash Avoidance and Mitigation*

During the joint EPA/NHTSA rulemaking for greenhouse gas and CAFE standards for model years 2017–2025, the Daimler Corporation, through its U.S. Mercedes Benz subsidiary, submitted comments seeking off-cycle credit for its vehicles' Level 1 automated crash avoidance features, on the theory that they would mitigate traffic congestion associated with collisions.[117] The joint agencies recognized that there is a relationship between congestion and emissions,[118] but categorically "prohibit[ed] off-cycle credits for [crash avoidance technologies] under any circumstances."[119] The agencies listed a number of Level 1 automated driving features for which they would not allow manufacturers even to make a case for offset credits, including Electronic Stability Control, Forward Collision Warning, Lane Departure Warning, and Adaptive Cruise Control.[120]

The agencies offered three rationales for declining to credit collision avoidance: first, that safety features are regulated by NHTSA under separate authority; second, that only verifiable, real-world emissions reductions can be credited; and third, that reductions must be traceable to an individual vehicle, not to network effects.

The agencies first argued that safety technology is more appropriately regulated through NHTSA's comprehensive vehicle safety programs than through the case-by-case off-cycle credit

117 *See* 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 No. EPA-HQ-OAR-2010-0799-9483 at A-6 to A-14 (Feb. 13, 2012) [hereinafter Daimler Comment].

118 *See* 2017 Mobile Source Standards, *supra* note 100, at 62,732 ("The agencies agree that there is a clear nexus between congestion mitigation and fuel/CO_2 savings for the entire onroad fleet.").

119 *Id*. at 62,730.

120 *See id.* at 62,733. Notably, in its rule establishing off-cycle credits for model years 2012–2016, EPA listed adaptive cruise control as one of the emerging technologies that prompted the establishment of off-cycle credits in the first place. *See* 2012 Mobile Source Standards, *supra* note 110, at 25,438.

program.[121] NHTSA sets stringent requirements for safety features in new vehicles. While the agencies provided little reasoning for why the safety regulations should preclude offset credits, it would certainly add complexity to the regulatory process for the two programs to overlap. EPA may also be concerned that as automated driving features are increasingly required by NHTSA's safety regulations, counting those features toward Clean Air Act compliance could undermine the technology-forcing goals of motor vehicle regulations. However, if real, quantifiable emissions reductions can be demonstrated from safety technologies, the agencies' exclusion of those benefits solely to prevent overlap between emissions standards and NHTSA's safety standards could be considered arbitrary.

The agencies appear to be making an argument similar to the one the Supreme Court rejected in the seminal *Massachusetts v. EPA*.[122] There, EPA declined to regulate vehicles' greenhouse gas emissions in part because it considered NHTSA's fuel economy standards to be a more appropriate avenue for regulation.[123] The court rejected this approach in strong terms, holding that "[t]he fact that DOT's mandate to promote energy efficiency by setting mileage standards may overlap with EPA's environmental responsibilities in no way licenses EPA to shirk its duty to protect the public 'health' and 'welfare.'"[124] Under the APA, the joint agencies must provide a rationale for rejecting Daimler's request for congestion mitigation credits that is not "arbitrary and capricious."[125] The agencies' argument that NHTSA has overlapping authority over the same technology has been rejected in another context, and there is little to suggest it makes more sense here.

Second, the agencies argued that "credits should be available only for technologies providing real-world improvements, the improvements must be verifiable, and the process by which credits

121 *See* 2017 Mobile Source Standards, *supra* note 100, at 62,732–33.

122 *See* Control of Emissions from New Highway Vehicles and Engines, 68 Fed. Reg. 52,922, 52,925 (Sept. 8, 2003) ("[E]ven if CO_2 were an air pollutant generally subject to regulation under the CAA, Congress has not authorized the Agency to regulate CO_2 emissions from motor vehicles to the extent such standards would effectively regulate car and light truck fuel economy, which is governed by a comprehensive statute administered by DOT.").

123 *See id.*

124 Massachusetts v. EPA, 549 U.S. 497, 501 (2007).

125 *See* 42 U.S.C. § 7607(d)(9) (1990).

are granted and implemented must be transparent."[126] The agencies further claimed that "none of these factors would be satisfied for credits for . . . indirect technologies used for crash avoidance systems."[127] It is certainly true that the emissions benefits from reduced congestion from avoided collisions are more difficult to quantify than emissions reductions "inside the wheelbase" of an individual vehicle, as conceded by the industry commenters.[128] The uncertainty of quantifying the benefits of crash avoidance technology probably justifies the agencies' decision not to include the technologies on their "menu" of pre-defined off-cycle credits. However, barring manufacturers from even attempting to justify their claims of benefits by categorically prohibiting any future off-cycle credits for crash avoidance renders the agencies' argument a self-fulfilling prophecy.

Courts have been skeptical of agency attempts to categorically exclude costs or benefits solely because they are difficult to quantify. An important example is the Ninth Circuit Court of Appeals' *Center for Biological Diversity v. NHTSA*, which rejected EPA's decision not to consider the greenhouse gas reduction benefits of CAFE standards. The court acknowledged that "while the record shows that there is a range of values, the value of carbon emissions reduction is certainly not zero."[129] By this logic, if Daimler or another stakeholder presents a credible estimate of the emissions reductions from automated vehicles' impact on congestion, the agency must not categorically exclude it unless it actually believes the technology would have no emissions impact.

Furthermore, even as EPA and NHTSA refused to consider Daimler's claimed congestion mitigation *benefits* for off-cycle

---

126 2017 Mobile Source Standards, *supra* note 100, at 62,733; 40 C.F.R. § 86.1869–12.

127 2017 Mobile Source Standards, *supra* note 100, at 62,733.

128 *See id.* ("Daimler agreed that attributing those fuel consumption/CO_2 benefits from reduced traffic congestion to specific individual technologies on specific vehicles would be difficult . . . ."); Daimler Comment, *supra* note 117, at A-7 (acknowledging the "inherent limitations in trying to quantify specific levels of CO_2 reductions to particular features" but arguing that CO_2 benefits of crash mitigation are clear, and that, using conservative assumptions, they should be reflected in off-cycle credits for crash avoidance technology).

129 Ctr. for Biological Diversity v. Nat'l Hwy. Traffic Safety Admin., 538 F.3d 1172, 1200 (9th Cir. 2008) (overturning as arbitrary NHTSA's determination that "the value of reducing emissions of . . . greenhouse gases [was] too uncertain to support . . . inclusion among the savings in environmental externalities").

credits, the agency did calculate congestion *costs* in the rule's Regulatory Impact Analysis.[130] The agency noted that greater fuel efficiency required by the rule would lead to a reduced cost per mile for drivers, producing a small rebound effect.[131] The increased VMT would, in turn, result in greater congestion, though the effect was "likely to be relatively small in comparison to the value of fuel saved as a result of the standards."[132] The agency recognized that the congestion effects were "nevertheless important to include."[133] The agency may have a difficult time justifying the refusal of even the chance to quantify congestion *benefits* for off-cycle credits, while the agency itself quantifies congestion *costs* in the regulatory impact analysis.[134]

Finally, the joint agencies laid out a principle that "for a technology to be 'counted' under the off-cycle credit provisions, it must make direct improvements to the performance of the *specific* vehicle to which it is applied. The agencies have never considered indirect improvements for the fleet as a whole."[135] This principle undoubtedly makes the agencies' job much easier, by excluding overall network effects that are more difficult to quantify. However, it carries with it the potential to seriously undercount the effects of important emerging technologies. As discussed above, the greatest energy and emissions impacts of automated vehicles will come from network effects that are, by definition, not traceable to a particular vehicle's tailpipe.[136] Furthermore, while the agencies are likely correct that indirect improvements for the fleet as a whole have not been considered previously in setting environmental standards, this may reflect only the novelty of the question rather than any past reasoned decision by the agency to

130 *See* EPA, Regulatory Impact Analysis: Final Rulemaking for 2017–2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards 7–28, Docket No. EPA-HQ-OAR-2010-0799-12013 (Aug. 2012) (projecting over $32 billion in disbenefits from additional accidents, congestion, and noise costs as automobile use becomes more efficient and cheaper, and thus increases).

131 *See* 2017 Mobile Source Standards, *supra* note 100, at 62942.

132 *Id.*

133 *Id.*

134 *Cf.* RICHARD REVESZ & MICHAEL A. LIVERMORE, RETAKING RATIONALITY 65 (2008) ("If we look under the rug to find costs, we have to look between the couch cushions for the benefits.").

135 2017 Mobile Source Standards, *supra* note 100, at 62,733 (emphasis added).

136 *See supra* notes 93–94 and accompanying text.

exclude such effects. Automated technologies have the potential to create significant fleetwide environmental externalities, either positive or negative. Traditional emissions control technologies may simply never have presented this question.

Furthermore, while it may be that EPA has never recognized fleetwide externalities in the context of offset credits, EPA has explicitly granted incentive multipliers based on indirect effects.[137] These incentives credit new vehicles at greater than their actual environmental performance in pursuit of market development benefits that could have environmental benefits in the future.[138] As previously discussed, EPA concluded that CNG vehicles' GHG performance did not make them a "game-changing" technology justifying regulatory incentives in their own right.[139] The agency nonetheless granted an incentive to CNG vehicles on the theory that infrastructure developed for fueling CNG could later be repurposed for hydrogen fuel cell vehicles, which the agency does consider "game changers."[140] The agency's refusal to allow manufacturers to seek credit for actual, present emissions reductions from collision mitigation is striking when compared to credits granted to the more speculative and indirect future benefits from adoption of additional technologies like hydrogen vehicles.

b. *Navigation System Congestion Mitigation and Avoidance*

Industry commenters, including global positioning system (GPS) provider Garmin, also sought off-cycle credits for GPS navigation systems that have the ability to help drivers choose efficient routes and avoid traffic congestion.[141] While GPS with

137 *See supra* notes 105–106 and accompanying text.

138 *See* 2017 Mobile Source Standards, *supra* note 100, at 62,811 ("[P]roviding temporary regulatory incentives for certain advanced technologies will decrease the overall GHG emissions reductions associated with the program in the near term. EPA believes it is worthwhile to forego modest additional emissions reductions in the near term in order to lay the foundation for the potential for much larger 'game-changing' GHG emissions and oil reductions in the longer term."); EPA, 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards: EPA Response to Comments at 4-45, 4-64, Docket No. EPA-HQ-OAR-2010-0799-12006 (Aug. 2012) [hereinafter "EPA 2017 Response to Comments"] (Comments of Institute for Policy Integrity and Natural Resources Defense Council).

139 *See* 2017 Mobile Source Standards, *supra* note 100, at 62,815.

140 *See id.*

141 *See* 2017 Mobile Source Standards, *supra* note 100, at 62,733–34; EPA

traffic avoidance is not itself an automated driving technology, EPA's treatment of this request could have implications for future treatment of efficient routing systems in automated Level 4 or 5 vehicles, which could be much more effective in routing vehicles away from congested roadways.[142] Ultimately, EPA declined to permit credits for navigation systems on its pre-defined menu of off-cycle credits, but left open EPA's "alternate demonstration methods" to potentially secure credits on a case-by-case basis.[143] However, the agencies stressed that "applicants would face formidable burdens of showing that improvements over baseline are legitimate, reliably quantifiable, certain, and transparently demonstrable."[144]

The final rule specified that any applicant wishing to claim credit for a navigation system enabled by GPS would need to prove that the service would be available for the useful life of the vehicle (most are subscription based), collect data to prove drivers were choosing routes that improve fuel economy, and prove accurate any traffic information used for route selection.[145] At present, the agencies predict that "meeting the burden of proof for these classes of technologies will be extremely difficult."[146] However, these challenges could be overcome with advanced automated driving technologies, as vehicles could be programmed to automatically select the most efficient route, and could collect data to verify their impacts. Thus, in the future, benefits could presumably be quantified with greater ease.

While EPA's skeptical language puts navigation system manufacturers on notice not to expect credit for present-day systems, the agency has left open the door to incentives for more verifiable and consistent efficient routing programs in the future, such as those that would likely be installed in an automated Level 4 or 5 vehicle. A broader question, however, is whether the agency would credit a vehicle avoiding an overcrowded highway only for

2017 Response to Comments, *supra* note 138, at 7-77; Comment Submitted by Motor & Equipment Manufacturers Association (MEMA) 9, Docket No. EPA-HQ-OAR-2010-0799-9478 (Feb. 13, 2012).

142 *See supra* notes 37–43.

143 *See* EPA 2017 Response to Comments, *supra* note 138, at 7-95; 2017 Mobile Source Standards, *supra* note 100, at 62,735–36.

144 2017 Mobile Source Standards, *supra* note 100, at 62,736.

145 *See id.* at 62,734.

146 *Id.*

the vehicle's own avoided emissions, or also for refraining from exacerbating the congestion experienced by other vehicles. EPA distinguishes between emissions reductions from congestion *avoidance* by the individual vehicle with the navigation system, and congestion *mitigation*, or the reduction of congestion experienced by other vehicles.[147] Consistent with its treatment of crash avoidance impacts, EPA will allow manufacturers to apply for off-cycle credit only for the congestion avoidance emissions impacts that are traceable to an individual vehicle.[148]

3. *Implications for Clean Air Act Treatment of Advanced Automated Vehicles*

The principle that offset credits will be granted only for emissions reductions traceable to a specific vehicle may be the sort of policy choice for which the agency receives deference from the courts. And indeed, limiting credits to only those emissions reductions that can be measured "inside the wheelbase" of an individual vehicle simplifies the agency's task, because quantifying the emissions impacts of effects like congestion mitigation and reduced collisions is complex, with a fair amount of uncertainty.[149] Limitation to "inside the wheelbase" credits would still incentivize manufacturers to adopt and promote some automated driving technologies, such as systems that improve the efficiency of acceleration and deceleration, or communicate with stoplights to reduce the need to stop at intersections. These technologies would primarily decrease the emissions of individual vehicles, and thus would pass EPA's test for off-cycle credits. However, limiting credits to only those "inside the wheelbase" could needlessly prevent the agency from spurring the adoption of the most environmentally transformative applications of automated driving technology.

Benefits attributable to network effects are certainly more difficult to quantify.[150] This does not, however, justify a conclusion that the reductions are not "real" or are merely

147 *See id.* at 62,733 n.300.

148 *See id.*

149 *See* 2017 Mobile Source Standards, *supra* note 100, at 62,733 n.301 (citing industry commenters' concessions that congestion mitigation pollution reductions are comparatively difficult to quantify).

150 *See id.*

"speculative," as the agencies suggest.[151] Indeed, the agencies concede that "there is a clear nexus between congestion mitigation and fuel/CO_2 savings for the entire onroad fleet."[152]

The Clean Air Act already allows states to claim credit for programs that improve collision response and clearing times, shift traffic loads to less congested times of day, or time traffic signals to better manage traffic even without reducing VMT.[153] The fact that these sorts of operational congestion mitigation measures have traditionally been under the purview of states and local governments may simply reflect that, until now, individual vehicle technology could not meaningfully address road congestion. The agency's decision to bar all consideration of network effects risks ignoring the potentially transformative environmental benefits of automated driving technology, and fully ceding the field of influencing its development path to agencies without an emissions control mandate. At any rate, there is precedent in local Transportation Control Measures for Clean Air Act recognition that moving a trip from a congested road to a less congested road has benefits beyond those experienced by an individual vehicle.[154]

151 *See* Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172, 1200 (9th Cir. 2008) (holding that NHTSA's determination that "the value of reducing emissions of . . . greenhouse gases [was] too uncertain to support . . . inclusion among the savings in environmental externalities" was arbitrary and capricious). *Contra* 2017 Mobile Source Standards, *supra* note 100, at 62733 (EPA distinguishes between "technologies providing direct and reliably quantifiable" emissions reductions, and "technologies which provide those improvements by indirect means, where the improvement is not reliably quantifiable, and may be speculative (or in many instances, non-existent), or may provide benefit to other vehicles on the road more than for themselves.").

152 2017 Mobile Source Standards, *supra* note 100, at 62,733.

153 *See generally* EPA, TRANSPORTATION CONTROL MEASURE INFORMATION DOCUMENTS: HIGH OCCUPANCY VEHICLE LANES, 400-R-92-006 (1992).

154 It should be noted that much of EPA's rationale for these programs is to address pollutants that cause harm at greater concentrations, such as ozone precursors. *See, e.g.*, EPA, TRANSPORTATION CONTROL MEASURES: WORK SCHEDULE CHANGES 2, EPA 420-S-98-014 (1998) (discussing how states can encourage staggered work hours to "spread a given amount of traffic over a longer period of time around peak periods" to address ozone concentrations); EPA, TRANSPORTATION CONTROL MEASURES 12, EPA-430-R-09-040 (Mar. 2011) (describing variable tolling schemes charging freight trucks lower tolls during off-peak travel times). However, congestion also increases GHG emissions from each vehicle, by leading to less efficient driving. *See* U.S. DEP'T OF TRANSP., TRANSPORTATION AND GLOBAL CLIMATE CHANGE: A REVIEW AND ANALYSIS OF THE LITERATURE 34, DOT-T-97-03 (1998) ("improved flow of traffic [] result[s] in lower emissions of greenhouse gases and greater fuel efficiency").

Furthermore, agencies already quantify congestion impacts from increased VMT in the rule's Regulatory Impact Analysis.[155]

Even if a sharp distinction between emissions reductions inside and outside the wheelbase were justified, emerging automated vehicle technologies may begin to blur that distinction in practice. For example, "platooning" reduces a vehicle's emissions by avoiding unnecessary acceleration, deceleration, and lane changes, but even greater efficiency gains come from the reduced aerodynamic drag of synchronized, close distance driving.[156] This effect cannot easily be attributed to a single vehicle, because it emerges only from multiple vehicles acting in concert. It nevertheless creates real, quantifiable benefits for all vehicles.[157] Where each vehicle both contributes to and benefits from efficient operation of the others, application of a strict principle that only individual vehicles' emissions savings can be credited becomes difficult to apply, and would systematically undercount environmental benefits. However, the model year 2017 rule includes a specific categorical exclusion of offset credits for adaptive cruise control, a precursor technology for platooning, as well as a crash avoidance feature.[158]

In denying offset credits for indirect emissions reductions, the agency cites concerns that manufacturers could reduce their compliance obligations with offset credits that are speculative or non-existent.[159] However, some environmental commenters point out that carefully verified, genuine offset credits can be used to justify more stringent overall standards.[160] Indeed, EPA experimented with this approach when it assumed that manufacturers would nearly all adopt certain efficiency

155 *See* 2017 Mobile Source Standards, *supra* note 100, at 62,942.

156 *See supra* note 39.

157 *See supra* note 39 and accompanying text.

158 *See supra* note 120.

159 *See* 2017 Mobile Source Standards, *supra* note 100, at 62,728 ("Commenters' ultimate concern is that the off-cycle credit flexibility could create windfall credits or avoid cost effective 2-cycle improvements.").

160 *See* EPA 2017 Response to Comments, *supra* note 138, at 7-7 ("As GHG reductions are identified and evaluated, EPA should consider the widespread adoption of these technologies when setting the stringency of future standards."); *see also* Comment of Center for Biological Diversity on 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards 20, EPA-HQ-OAR-2010-0799-9479 (Feb. 13, 2012).

improvements to vehicle air conditioners.[161] Instead of merely allowing these improvements to count toward meeting efficiency standards, the agencies set tighter standards, knowing that the improvements would be used to meet them.[162] If the agencies allow manufacturers to use "outside the wheelbase" emissions reductions as a compliance method, they can and should set overall emissions standards lower to account for these effects. For new off-cycle credits, manufacturers bear the burden of applying for recognition of specific new technologies.

With two exceptions, however, EPA has not considered the availability of off-cycle credits in setting its overall vehicle emissions standards.[163] The agency claimed a lack of sufficient data on the effectiveness, cost, and availability of technologies that could provide off-cycle credits.[164] Without being able to accurately project the quantity of emissions expected to be avoided through use of off-cycle technology, the agency declined to make off-cycle credits a part of the standards calculation.[165]

The agency faces an additional risk if it continues to categorically exclude network effects from its emissions calculations. In 2015, the House Energy and Commerce Subcommittee on Commerce, Manufacturing, and Trade considered draft legislation that would have automatically assigned offset credits for emissions reductions "outside the wheelbase" of connected vehicles and those with certain automated safety technologies.[166] However, where the existing offset credit program places the burden of proving emission reductions on auto manufacturers, the discussion draft simply provides a minimum credit for all vehicles with a requisite number of advanced technologies, with no obligation to verify that the credit reflects actual emissions reductions.[167] Greg Dotson, a witness

161 *See* 2017 Mobile Source Standards, *supra* note 100, at 62,720.

162 *See id.*

163 *See* 2017 Mobile Source Standards, *supra* note 100, at 62,727.

164 *See id.*

165 *See id.*

166 *See Examining Ways to Improve Vehicle and Roadway Safety: Hearing Before the Subcomm. on Commerce, Mfg., & Trade of the H. Comm. on Energy & Commerce*, 114th Cong. (2015), https://energycommerce.house.gov/hearings-and-votes/hearings/examining-ways-improve-vehicle-and-roadway-safety.

167 *See* Discussion Draft § 502 (Oct. 13, 2015), http://docs.house.gov/meetings/IF/IF17/20151021/104070/BILLS-114pih-DiscussionDraftonVehicleandRoadwaySafety.pdf (draft legislation on vehicle and roadway safety).

representing the Center for American Progress, testified that the size of the bill's credits would erode motor vehicle standards by allowing manufacturers to comply through unverified and overly generous allowances rather than verifiable emissions reductions.[168]

To be sure, a blanket allowance for advanced vehicles makes little sense, because offset credits exist to bring vehicles' regulatory emissions value as close as possible to their actual emissions value, a goal not served by selecting arbitrary and inflated values. However, regulations that categorically exclude all network effects from emissions calculations are no less arbitrary. If the agency wishes to avoid the sort of blunt legislative tinkering reflected in the discussion draft, it should adopt a more scientifically rigorous approach, whereby industry must justify its proposed values for emissions reductions under the strict oversight of EPA. Tightening overall standards based on those reductions would ensure that manufacturers, and not the breathing public, would bear at least a large part of the uncertainty risk.

B. *State Vehicle Emissions Standards*

If automated vehicles prove to have verifiable environmental benefits, states may wish to consider requiring that vehicles be equipped with such technology to attain National Ambient Air Quality Standards (NAAQS). However, doing so would be quite difficult under prevailing readings of the Clean Air Act. States unambiguously retain the authority to set regulations for driving, vehicle registration, driver licensing, and other issues surrounding the operation of motor vehicles.[169] At the same time, the Clean Air Act preempts states from "adopt[ing] or attempt[ing] to enforce any standard relating to the control of emissions from new motor vehicles or new motor vehicle engines. . . ."[170] An important question for the courts has been the scope of this preemption over state attempts to incentivize more environmentally friendly vehicles. Notwithstanding the general federal preemption, the State

168 *See Examining Ways to Improve Vehicle and Roadway Safety: Hearing Before the Subcomm. on Commerce, Mfg., & Trade of the H. Comm. on Energy & Commerce*, Transcript, at 140–43, http://docs.house.gov/meetings/IF/IF17/20151021/104070/HHRG-114-IF17-Transcript-20151021.pdf (response of Greg Dotson, Vice President for Energy Policy, Center for American Progress to Rep. Frank Pallone).

169 *See* Engine Mfrs. Ass'n v. EPA, 88 F.3d 1075, 1094 (D.C. Cir. 1996).

170 42 U.S.C. § 7543 (2012).

of California plays a unique role. Because of the tremendous air quality challenges faced by the state, and its pioneering role in regulating vehicle emissions, California was not preempted by the Clean Air Act, and continues to have the unique ability to set its own vehicle standards.[171]

1. *Federal Preemption of State Standards*

Attempts by states to require either vehicle sellers or certain classes of purchasers to meet technology requirements beyond federal emissions standards have met with strong resistance. In *Motor & Equipment Manufacturers Association (MEMA) v. EPA*, California attempted to limit overly burdensome routine maintenance requirements for new vehicles, so that manufacturers could not blame vehicle purchasers for substandard emissions performance.[172] The D.C. Circuit acknowledged that the state had an interest in the vehicle standards, and determined that these "in-use" regulations were of the type that would be preempted by the Clean Air Act (but were therefore of the type for which California could seek a waiver).[173]

The regulations at issue in *MEMA v. EPA* were general rules applicable to all vehicles sold in the state, and were thus directly parallel to federal Clean Air Act regulations. Thus, it makes a certain sense that they would have been preempted if not for California's waiver eligibility. However, a more difficult case arose in *Engine Manufacturers Association v. South Coast Air Quality Management District* (SCAQMD), in which the Los Angeles air regulator required commercial fleet operators in the area to meet certain emissions requirements for the vehicles they acquired for industrial use.[174] Rather than limiting what vehicles could be sold in the local market, the rules represented an attempt at solving a local air quality hotspot by regulating the equipment *purchases* of only a subset of local industry.[175] In an 8-1 decision,

171 *See* 42 U.S.C. § 7543(b) (2012) (the only state that the waiver provision applies to is California).
172 *See* Motor & Equipment Manufacturers Ass'n, Inc. v. EPA, 627 F.2d 1095, 1103 (D.C. Cir. 1979).
173 *See id.* at 1107–09.
174 *See* Engine Manufacturers Ass'n v. S. Coast Air Quality Mgmt. Dist., 158 F. Supp. 2d 1107, 1114 (C.D. Cal. 2001), vacated, 541 U.S. 246 (2004) (describing the history and structure of the fleet rules).
175 *See id.*

the Supreme Court held that, though the regulations placed no direct requirements on manufacturers, they were nevertheless "standard[s] relating to the control of emissions from new motor vehicles or new motor vehicle engines," subjecting them to preemption by the Clean Air Act.[176] Any distinction between regulating sellers and purchasers was irrelevant for preemption purposes.[177]

Local governments' attempts to create green incentives for taxi fleets have also been preempted by federal standards. Taxis are generally subject to pervasive local regulation of vehicle attributes, livery schemes, fares, payment systems, and driver qualifications.[178] Nevertheless, state requirements that taxis use hybrid engines or meet fuel efficiency standards have suffered a series of defeats in the courts.[179] In *Metropolitan Taxicab Board of Trade v. City of New York*, a district court enjoined implementation of a New York City rule that would have allowed taxi owners to lease hybrids to their drivers at a higher rate than conventional taxis.[180] The court found, based on a review of the economics of the industry, that the rule comprised a de facto mandate to purchase the hybrid vehicles, and was therefore a preempted emissions standard.[181]

Regulations that provide smaller incentives for green taxis, while still leaving conventional taxis free to operate, have fared somewhat better. A Texas district court distinguished the de facto

176 *See* Engine Mfrs. Ass'n v. S. Coast Air Quality Mgmt. Dist., 541 U.S. 246, 251 (2004) (citing 42 U.S.C. § 7543(a)).

177 *See id.* at 252–54 ("a standard is a standard even when not enforced through manufacturer-directed regulation").

178 *See* Paul Stephen Dempsey, *Taxi Industry Regulation, Deregulation & Reregulation: The Paradox of Market Failure*, 24 TRANSP. L.J. 73, 75–76 (1996); *see also* Ass'n of Taxicab Operators, USA v. City of Dallas, 760 F. Supp. 2d 693, 697 (N.D. Tex. 2010) ("'The operation of taxicabs is a local business,' and 'Congress has left the field largely to the states.' Neither before or since the enactment of the Clean Air Act has Congress sought to bring the taxicab industry under federal regulatory control.") (quoting Buck v. California, 343 U.S. 99, 102 (1952)).

179 *See* Christina Ma, *Hybridizing Federal and State Regulation of Clean Taxis Introduction*, 42 ENVTL. L. REP. NEWS & ANALYSIS 10840, 10846–47 (2012) (criticizing cases that hold local taxi regulations preempted).

180 *See* Metro. Taxicab Bd. of Trade v. City of New York, 633 F. Supp. 2d 83, 105 (S.D.N.Y. 2009), *aff'd*, 615 F.3d 152 (2d Cir. 2010).

181 *See id.* at 100 ("[T]he Lease Cap Rules do not present viable options for Fleet Owners and instead operate as an effective mandate to switch to hybrid vehicles.").

mandate in *Metropolitan Taxicab* from a Dallas rule allowing taxis burning compressed natural gas (CNG) to move to the head of airport lines, saying that the latter did not constitute a "standard."[182] The key distinction appears to be whether the regulations are binding requirements to purchase or sell vehicles with identifiable environmental attributes, or whether the policy is a bona fide voluntary incentive program. Any compulsory regulation attempting to reduce emissions by requiring the purchase or sale of vehicles with automated driving technology would thus almost certainly be preempted by section 209.

2. *California State Standards*

Upon application by California, EPA must grant a waiver of preemption enabling the California standards, unless it finds that they are arbitrary, unnecessary to meet a "compelling or extraordinary" need of California, or would not be consistent with the health based standards in the Act.[183] Furthermore, states with nonattainment areas are allowed to adopt California's standards as an alternative to federal standards,[184] which at least 15 states have done.[185]

Only one of California's waiver applications has ever been denied by EPA: California's first attempt at regulating vehicle greenhouse gas emissions.[186] The incoming Obama administration later reversed this denial, allowing California's standards to move forward.[187] However, at the same time, the federal government was in the process of resolving its own obligations to regulate

182 *See* Ass'n of Taxicab Operators, USA v. City of Dallas, 760 F. Supp. 2d 693, 698 (N.D. Tex. 2010).

183 *See id.* The waiver has been denied as unnecessary only once, when California imposed vehicle standards to address greenhouse gas emissions in 2004. This waiver denial, however, was withdrawn and reversed by the new presidential administration in 2009.

184 *See* 42 U.S.C. § 7507 (2012).

185 *See* EPA, States Adoption Status of CARB Rules, CISD-11-06, Enclosure 2 (May 3, 2011), https://iaspub.epa.gov/otaqpub/display_file.jsp?docid=24724&flag=1.

186 *See* Notice of Decision Denying a Waiver of Clean Air Act Preemption for California's 2009 and Subsequent Model Year Greenhouse Gas Emission Standards for New Motor Vehicles, 73 Fed. Reg. 12,156 (Mar. 6, 2008).

187 *See* Notice of Decision Granting a Waiver of Clean Air Act Preemption for California's 2009 and Subsequent Model Year Greenhouse Gas Emission Standards for New Motor Vehicles, 74 Fed. Reg. 32,744 (July 8, 2009).

vehicle greenhouse gas emissions.[188] That conflict was ultimately settled when the federal government agreed to set its own greenhouse gas standards and California adopted them.[189] However, California remains uniquely positioned to help guide automated vehicles on an environmentally advantageous development path.

The state's Air Resources Board is responsible for devising California's motor vehicle standards.[190] However, while California has been at the forefront of adopting technology-forcing regulations for low and zero emissions vehicles, the state has paid less attention to the emissions potential of automated vehicles. While the state road safety and transportation agencies have established a task force to prepare the state for automated vehicles, the Air Resources Board is not a member of the task force.[191] A report for the Air Resources Board recommends that the agency take a more active role in developing automated vehicle policy for the state, and especially act to encourage the development pathways that are expected to be environmentally beneficial.[192] Though the Air Resources Board has not yet used its unique authority to set state-based preferences for environmentally beneficial automated driving technology, its authority to do so would have a broader impact, as its standards could be adopted by other states.[193]

IV. REGULATING AUTOMATED DRIVING

EPA sets National Ambient Air Quality Standards for six "criteria pollutants,"[194] which states must meet by preparing State Implementation Plans,[195] or by submitting to a Federal

188 *See supra* note 99 and accompanying text.

189 *See* Letter from Mary D. Nichols, Chair, Cal. Air Res. Bd., to Lisa Jackson, Adm'r, U.S. EPA & Ray LaHood, Sec'y, U.S. Dep't of Transp. (July 28, 2011), http://www.epa.gov/otaq/climate/letters/carb-commitment-ltr.pdf.

190 *See Introduction to the Air Resources Board*, CAL. AIR RES. BD. (Dec. 30, 2015), http://www.arb.ca.gov/html/brochure/arb.htm; *see also, e.g.*, Cal. Health & Safety Code §§ 43000–44299.91.

191 *See* BARCHAM, *supra* note 31, at 10.

192 *See id.* at 25–26.

193 *See* 42 U.S.C. § 7507 (2012).

194 *See Criteria Air Pollutants*, EPA, https://www.epa.gov/criteria-air-pollutants (last visited March 30, 2016); *see also* 42 U.S.C. § 7408 (2012) (providing authority for EPA to identify criteria pollutants).

195 *See* 42 U.S.C. § 7410 (2012).

Implementation Plan prepared by EPA.[196] While state SIPs cannot set technology based standards for new motor vehicles, states retain the authority to regulate vehicle use directly to improve air quality through the use of Transportation Control Measures (TCMs). States can restrict the use of motor vehicles, provide incentives for carpooling or telework, build transit or carpooling infrastructure, require emissions testing, or adopt other regulations affecting transportation to help achieve the NAAQS. States with areas that do not meet air quality standards are required to adopt TCMs.[197] States could use these tools to guide the development of automated vehicles to provide greater environmental benefits.

The Clean Air Act expressly and unambiguously defers to states to address motor vehicle emissions if they do so through TCMs, and not through vehicle standards.[198] In all states, TCMs are an option for meeting air quality standards, while in serious, severe, or extreme non-attainment areas, they are mandatory.[199] The Clean Air Act includes a non-exhaustive list of TCMs, with some directed at reducing overall vehicle miles traveled in single occupancy vehicles by providing alternatives like public transit, carpool (HOV) and bus lanes, bike and pedestrian facilities, and employer carpooling incentives.[200] Other measures are directed at discouraging vehicle travel, such as congestion and parking pricing, parking supply management, and telework incentives.[201] The statute also includes measures to decrease the energy intensity of vehicles on the road, such as improving the efficiency of traffic flow and reducing idling.[202] Certain state and local policies to guide development of automated technologies may already count as TCMs under existing definitions, while others would likely

196 *See* 42 U.S.C. § 7410(c) (2012).

197 *See* 42 U.S.C. § 7511a(c)(5) (2012).

198 *See* 42 U.S.C. § 7408(f) (2012) (listing statutory TCMs); Engine Mfrs. Ass'n v. EPA, 88 F.3d 1075, 1094 (D.C. Cir. 1996) ("[T]he longstanding scheme of motor vehicle emissions control has always permitted the states to adopt in-use regulations—such as carpool lanes, restrictions on car use in downtown areas, and programs to control extended idling of vehicles—that are expressly intended to control emissions."); *see also, generally*, EPA, TRANSPORTATION CONTROL MEASURES 1–2, EPA-430-R-09-040 (Mar. 2011).

199 *See* 42 U.S.C. § 7511a(c)(5) (2012) (requiring TCMs for serious non-attainment areas); 42 U.S.C. § 7511a(d) (2012) (severe areas); 42 U.S.C. § 7511a(e) (2012) (extreme areas).

200 *See* 42 U.S.C. § 7408(f) (2012); *see also, generally*, EPA, *supra* note 194.

201 *See* sources cited *supra* note 200.

202 *See* sources cited *supra* note 200.

require regulatory changes to be fully credited. In either case, states will have to justify that the policies will have a beneficial impact on emissions in order to receive SIP credit.[203]

It should be noted at the outset that, for reasons discussed above, automated driving will quite likely increase total vehicle miles traveled (VMT),[204] and could increase the number of trips taken in private vehicles at the expense of public transit in cities where transit is a viable option.[205] However, where TCMs are required, EPA has made clear that the key consideration is not whether TCMs are successful in constraining total vehicle miles, but whether *emissions* from the auto sector are controlled.[206] New technologies make this distinction much more important, as the emissions gap between high and low polluting vehicles grows wider. With the advent of hybrid vehicles, vehicle electrification, and eventually platooning and other highly efficient vehicle types and practices, the correlation between VMT and emissions may grow increasingly unstable.[207] To that end, TCMs that attempt to reduce the emissions intensity of travel, rather than those that attempt to reduce travel more generally, will be more relevant to state recognition of the emissions impacts of automated driving.

Still, unlike vehicle emissions standards, TCMs are inherently directed at reducing fleetwide emissions, so are particularly well suited to filling the regulatory gap left by a lack of recognition of automated vehicles in Title II emission standards. However, because TCMs are adopted by state and local policymakers, they do not generally have the same capacity to drive and standardize technology investments by automakers.

203 *See* DOUGLAS EISINGER ET AL., EPA, TRANSPORTATION CONTROL MEASURE: STATE IMPLEMENTATION PLAN GUIDANCE 79, 450/2/89-020 (Sept. 1990).

204 *See supra* notes 57–71.

205 *But see supra* note 72.

206 *See* State Implementation Plans; General Preamble for the Implementation of Title I of the Clean Air Act Amendments of 1990, 57 Fed. Reg. 13498, 13523 (Apr. 16, 1992) ("It is reasonable to interpret this language as requiring that VMT growth must be offset only where such growth results in emissions increases from the motor vehicle fleet in the area.").

207 This instability has also presented a potential challenge for road funding, currently accomplished through fuel taxes, which drivers of electric vehicles can avoid. *See* GOV'T ACCOUNTABILITY OFF., PILOT PROGRAM COULD HELP DETERMINE THE VIABILITY OF MILEAGE FEES FOR CERTAIN VEHICLES 46 (2012), http://www.gao.gov/assets/660/650863.pdf. Fuel consumption is a more reasonable proxy for emissions than VMT.

The "traffic flow improvement" category of TCMs has historically included coordinated signaling, one-way street conversions, reversible lane systems, improvements to intersections, systems to reduce response times for clearing freeway accidents, and other approaches to reduce congestion.[208] When roadways are congested, traffic speed is too slow for optimal engine operation, and drivers must frequently brake, accelerate, and idle, all of which increase emissions.[209] Designing facilities to allow drivers to travel at a constant speed theoretically avoids some of these emissions.[210] However, while traffic flow improvements can mitigate some of the emissions from individual vehicles, more convenient travel also induces additional demand. The Transportation Research Board of the National Academies examined traffic flow improvements in 2005, and found that several cities' major investments in traffic flow produced almost no actual emissions reduction benefit, because new travel offset any improvements in flow.[211] Nevertheless, the fact that traffic flow improvements are recognized approaches for states to implement their Clean Air Act responsibilities may be an important initial step to credit automated vehicle efficiencies, if verified and substantiated. Automated driving could promote traffic flow efficiency,[212] and thus, local measures to promote and facilitate its use would be eligible for SIP credit as TCMs under the existing "traffic flow improvement" definition. This is particularly important because the most promising automated driving applications, such as platooning and active intersection

---

208 *See* EPA, *supra* note 198, at 8–9.

209 *See* Matt Grote et al., *Including Congestion Effects in Urban Road Traffic CO_2 Emissions Modelling: Do Local Government Authorities Have the Right Options?*, 43 TRANSP. RESEARCH PT. D 95, 97 (2016).

210 *See* EPA, *supra* note 198, at 8–9.

211 *See* RICHARD DOWLING ET AL., PREDICTING AIR QUALITY EFFECTS OF TRAFFIC-FLOW IMPROVEMENTS, NCHRP Report No. 535 (2005) ("The impacts of individual traffic-flow improvement projects on regional daily VMT were on the order of a few hundredths of 1 percent. A 30-year improvement program impacted VMT by less than 1%. The impacts varied from a reduction in VMT to an increase in VMT, depending upon the specifics of each case study."); *see also, e.g.*, Robert B. Noland & Mohammed A. Quddus, *Flow improvements and vehicle emissions: Effects of trip generation and emission control technology*, 11 TRANSP. RESEARCH PT. D 1, 13 (2006) (arguing that, especially with new cleaner engines, the emissions effects of changes in congestion are minimal, and are rapidly erased by induced additional trips when traffic flow is improved).

212 *See supra* notes 36–43 and accompanying text.

management, will almost certainly require infrastructure investment and regulatory changes at the local level, which SIP credit would help incentivize.

Another extremely important TCM is the high occupancy vehicle (HOV) lane.[213] States have a strong incentive to promote carpools with a faster commute through dedicated lanes, as each additional passenger achieves mobility with virtually no marginal cost: existing empty seats provide the capacity.[214] To date, the United States has constructed over 2500 miles of HOV lanes.[215] App-enabled TNCs with human drivers have already begun using data aggregation and computer destination and route matching to enable strangers to efficiently carpool on-demand, taking advantage of HOV lanes.[216] In the future, automated vehicles may use a similar approach to effectively match riders with similar destinations so that trips may be combined, but at a lower price, with greater coverage, and with lower wait times. This would give automated vehicle riders access to existing HOV facilities. To the extent that an environmental benefit can be demonstrated, state action to provide regulatory incentives to automated vehicle operators to promote carpooling is likely cognizable as a TCM, similar to existing carpooling and vanpooling promotion programs. States could, for example, receive SIP credit for requiring that automated TNCs offer carpooling as a feature, or even for setting minimum standards for average passengers per vehicle.

If emissions reductions from automated driving are sufficiently demonstrated, states may desire to adopt separate "platooning" or automated driving lanes. There is precedent for

213 *See generally* EPA, TRANSPORTATION CONTROL MEASURE INFORMATION DOCUMENTS: HIGH OCCUPANCY VEHICLE LANES, 400-R-92-006 (1992).

214 *See* CYNTHIA J. BURBANK & NICK NIGRO, PEW CTR. ON GLOBAL CLIMATE CHANGE, SAVING OIL AND REDUCING GREENHOUSE GAS EMISSIONS THROUGH U.S. FEDERAL TRANSPORTATION POLICY 11 (2011) http://www.c2es.orgwww .c2es.org/docUploads/Saving-Oil-and-Reducing-GHG-Emissions.pdf.

215 *See* Sharon Shewmake, *Can Carpooling Clear the Road and Clean the Air? Evidence from the Literature on the Impact of HOV Lanes on VMT and Air Pollution*, 27 J. OF PLANNING LIT. 363, 363 (2012).

216 *See* Farhad Manjoo, *Car-Pooling Helps Uber Go the Extra Mile*, N.Y. TIMES (Mar. 30, 2016), http://www.nytimes.com/2016/03/31/technology/car-pooling-helps-uber-go-the-extra-mile.html; *cf. generally* MARK BURRIS ET AL., FED. HWY. ADMIN., CASUAL CARPOOLING SCAN REPORT, FHWA-HRT-12-053 (2010) (describing the practice of "slug lines" or "casual carpool lines," by which drivers pick up strangers along the roadside, and they commute together to make use of HOV lanes).

allowing vehicle technological attributes, particularly hybrid or electric engines, to be used for accessing limited lanes without the otherwise required number of passengers.[217] Though this change came through federal legislation specifically authorizing states to grant low emissions vehicles access to HOV lanes,[218] states that can show a benefit may still be able to allow HOV lane access to automated vehicles, or to establish separate vehicle lanes for that purpose.

If automated vehicles reach the point where they can park without a human driver, or can increase the mode share of vehicles that are not parked because they are shared, they could facilitate land use changes that would also be cognizable as TCMs.[219] EPA initially established its recommended parking limitations as methods of effectuating VMT reductions, as it was assumed that constraints on parking would limit automobile trips.[220] A reduction in parking to reflect an increase in shared automated vehicles may not actually reflect a reduction in VMT, however, because it could instead reflect a greater utilization rate for vehicles on the road, and the ability to move parking outside of city centers. Still, reduced parking in downtown areas would also allow more dense development, which can lead to more pedestrian trips, and less overall automobile use outside of commuting times.[221]

Cities and states therefore have a number of policy options available to them to help shape automated vehicle technology, even if they are preempted from requiring it. However, if

---

217 *See High-Occupancy Vehicle Lanes*, U.S. DEP'T OF TRANSP. (Oct. 26, 2015), https://www.transportation.gov/mission/health/High-Occupancy-Vehicle-Lanes; *see also, e.g.*, *New York's Clean Pass Program*, N.Y. DEP'T OF TRANSP. (March 31, 2016), https://www.dot.ny.gov/programs/clean-pass (listing vehicles eligible for single occupancy use of the Long Island Expressway HOV lane); *Eligible Vehicle List: Single Occupant Carpool Lane Stickers*, CAL. AIR RES. BD., (Mar. 10, 2016), http://www.arb.ca.gov/msprog/carpool/carpool.htm (describing California's HOV-eligible vehicles).

218 *See* 23 U.S.C. § 166 (2006) (permitting states to allow single occupancy hybrid and low emission vehicles into high-occupancy vehicle (HOV) lanes); *see also* Daniel Ramish, *Government Regulatory Initiatives Encouraging the Development and Sale of Gas/Electric Hybrid Vehicles: Transforming Hybrids from a Curiosity to an Industry Standard*, 30 WM. & MARY ENVTL. L. & POL'Y REV. 231, 252 (2005).

219 *See* EISINGER, *supra* note 203, at 75–77 (suggesting land use changes to reduce emissions, such as infill development, reducing parking, and increasing density).

220 *See id.* at 20.

221 *See* SHOUP, *supra* note 60, at 158–62.

consumers' private vehicles are simply automated without policy support by government, many of the potential efficiencies of the technology may be squandered. The effect may be limited to pure increased VMT, a net negative to the environment.[222] A state's greatest opportunity for guiding the technology in an environmentally protective direction is through promotion of automated electric shared vehicles, both as transportation solutions in their own right, and as a complement to a robust public transit system.[223] Such a system would involve investments and regulatory actions at numerous levels, from designation of lanes and other facilities for automated operation, to regulation of vehicle fleet operators, to overhauling parking regulations.

Operating in dedicated lanes, automated driving technology holds great potential for improved efficiency. For example, cities may vary lane width to maximize roadway capacity, particularly if vehicle fleets are "right-sized" to provide single-occupancy vehicles for single passengers. Cities could also build on the current practice of reversing lane direction to reduce congestion at peak travel times by assigning lanes in real time.[224] If automated operation delivers on promises to achieve dramatic decreases in collisions, state and local governments will have to decide whether to reflect this fact in higher speed limits, which could provide mobility benefits, or, alternatively, to set speed limits to optimize energy efficiency. It would even be possible to vary traffic speeds in real time to balance mobility needs with air quality. All of these changes would require a central traffic management system with communication between infrastructure and vehicles, which state and local governments are uniquely in a position to provide. If a city were to take on such a holistic project, each of these steps' emissions impacts could be reflected in the state's SIP.

CONCLUSION

Automated vehicles have moved rapidly from the hypothetical to the imminent. Federal automated vehicle policy is currently being led primarily by regulators focused on vehicle safety. While this is a critically important aspect of automated vehicle policy, the conversation would benefit from greater engagement by regulators

222 *See supra* notes 82–84 and accompanying text.
223 *See supra* notes 82–88 and accompanying text.
224 *See supra* notes 90–94 and accompanying text.

with the experience and the authority to consider the environmental implications. Automated vehicles have the potential to contribute to cleaner air and more walkable cities, but they could also drive sprawl and choke freeways with even more traffic. The outcome depends in part on the actions of federal and state regulators.

A number of early decisions on automated vehicle technology have exposed an overly timid approach by EPA, which has laid out a blanket principle that the network effects of automated driving technologies will not be cognizable for purposes of vehicle emissions standards. States, meanwhile, are preempted from considering the broad emissions impact of new vehicle technologies, leaving no regulator with the ability to grapple with the important question of how to manage the most consequential environmental implications of self-driving cars. However, the state of California, thanks to its special status as a parallel motor vehicle emissions standard setter, can be very influential in this space if it so chooses.

State and local governments, in partnership with federal agencies, will bear much of the responsibility for determining how automated driving technologies will shape the urban environment. States already have many of the tools they need to encourage the most efficient use of automated vehicles and prepare for their eventual widespread use. States also have the ability, in many cases, to use responsible decision-making around automated vehicles to help meet their obligations under the Clean Air Act.

The capabilities of automated vehicles to save lives, to help clean the air, to provide mobility to underserved people, and to contribute to livable cities have captured much public imagination. Because automated driving technology is in its nascent stage, regulators should use this time to plan for how its environmental impact should be reflected under the Clean Air Act. The time to do so is rapidly expiring.