The Driverless Horseless Carriage: Steering the Anticipated Environmental Impacts of Autonomous Vehicles

Arthur Harrington and Sarah Schenck

Henry Ford revolutionized the automobile industry—and ultimately the American way of life—in the early twentieth century by cultivating the moving assembly line, ushering in the age of mass production. *The Third Industrial Revolution*, The Economist (Apr. 21, 2012). The post-World War II housing boom coupled with the passage of the Interstate Highway Act of 1956 led to the construction of a vast interstate highway system. The contemporaneous increased affordability of personal automobiles made living outside of city centers more accessible than ever before. Seth Browner, *The Post-World War II Suburb in the United States*, The First-Year Papers (2010–Present) 1, 1 (2013). Consequent land-use policies and restrictions engendered urban sprawl, leading to lasting socioeconomic, human health, and environmental impacts still tangible today. Just as the "horseless carriage" revolutionized land use and the American way of life in the twentieth century, autonomous vehicles (AVs) will have an enormous impact on land use and the environment in the twenty-first century.

Policy makers have an opportunity to anticipate the effects of this technological development on the environment rather than retroactively manage the unintended consequences. This article explores the manner in which emerging AV technology could impact current traditional strategies for managing environmental costs and benefits. The first section presents an overview of AV technology, the expected timeline of development, and the current legislative landscape. The second section examines potential impacts to the built and natural environment using history as a blueprint. Finally, the third section analyzes the impacts of these environmental costs and benefits on traditional environmental policies and recommends changes to such policies to anticipate and account for these AV impacts.

Overview of AV Technology and Legislative Landscape

In September 2016, the U.S. Department of Transportation issued its Federal Automated Vehicle Policy (Policy) in an effort to pave the way for safe design, development, testing, and deployment of AVs. Press Release, U.S. Dep't of Transp., U.S. DOT Issues Federal Policy for Safe Testing and Deployment of Automated Vehicles (Sept. 20, 2016). The Policy includes guidance for AV manufacturers, developers, and other organizations on 15 safety assessment areas (ranging from human machine interface to ethical considerations to vehicle cybersecurity), a model state policy, and new regulatory tools and authority to assist policy makers in undertaking the challenges involved in regulating AVs. Because of the multiple definitions for the various levels of automation, it also standardizes these levels by adopting the definition of SAE International (initially established as the Society of Automotive Engineers). U.S. Dep't of Transp., *Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety* 9 (Sept. 2016).

The SAE levels can be broken down into six categories with the following descriptions. Level 0 (No Automation): A human driver is in complete control at all times of all car functions. Level 1 (Driver Assistance): A driver assistance system of either steering or acceleration/deceleration can assist a human driver with some driving tasks. The human driver performs all remaining aspects of driving. Level 2 (Partial Automation): A driver assistance system executes both steering and acceleration/deceleration. The human driver performs all remaining aspects of driving. Level 3 (Conditional Automation): A driver assistance system executes all aspects of the driving tasks and monitors the driving environment. The human driver is expected to respond appropriately to a request to intervene. Level 4 (High Automation): A driver assistance system executes all aspects of the driving tasks and monitors the driving environment, even if the human driver does not respond appropriately to a request to intervene. The driver assistance system is limited to certain environments and under certain conditions. Finally, Level 5 (Full Automation): The automated system executes all aspects of the driving tasks under all conditions that a human driver could manage. SAE International, *Automated Driving* 2 (2014).

Tesla's Autopilot system is one of the best-known examples of Level 2, which includes adaptive cruise control, automatic lane changes, and automatic steering, while still requiring the driver to be attentive. Uber, the largest ride-hailing company in the United States, launched a pilot fleet of AVs operating at Level 3 in Pittsburgh in September 2016. A handful of automakers, including BMW, Ford, and Volvo, expect to bring Level 4 AVs to the market for high-volume commercial use by 2021. The management consulting firm McKinsey & Company predicts that up to 15 percent of new cars could be fully autonomous by 2030 (though it is unclear whether that means Level 4 or Level 5). McKinsey & Co., *Automotive*

Mr. Harrington and Ms. Schenck are attorneys in the Environmental and Energy Strategies Group at Godfrey & Kahn, S.C., in Milwaukee, Wisconsin. They may be reached at ajharrin@gklaw.com and sschenck@gklaw.com.

revolution—perspective towards 2030: How the convergence of disruptive technology-driven trends could transform the auto industry 5 (Jan. 2016).

In 2015, 16 states introduced legislation related to AVs. Eight states (Nevada, California, Florida, Louisiana, Michigan, North Dakota, Tennessee, and Utah) and Washington, D.C., have actually passed legislation related to AVs, and Arizona's governor has issued an executive order directing state agencies to take steps to support AV testing and operation on public roads in Arizona. *Autonomous—Self-Driving Vehicles Legislation*, Nat'l Conference of State Legislatures (Oct. 25, 2016). Meanwhile, the same day Uber launched Level 3 AVs in Pittsburgh, aldermen in Chicago proposed an ordinance that would ban AVs in Chicago, calling it a "preemptive strike." They do not want Chicago streets to be used as an experiment because, they noted, "[n]o technology is one-hundred percent safe." Meg Graham, *Driverless Cars Could Be Banned by Chicago City Council*, Chi. Trib. (Sept. 14, 2016). Of course, neither is human piloting. The National Highway Traffic Safety Administration (NHTSA) estimates that 94% of road incidents in the United States are caused by human error, with only 2% attributed to vehicles (due to faulty tires, brakes, steering column, etc.), and the remaining 4% evenly split between environmental and unknown causes. Nat'l Highway Traffic Safety Admin., *Critical Reasons for Crashes Investigated by the National Motor Vehicle Crash Causation Survey* 1 (Feb. 2015). AV technology will materialize, whether municipalities and states are ready for it or not.

Potential Impacts on the Built and Natural Environment

Looking backward in time at the immense ripple effects the automobile had on shaping the physical and socioeconomic landscape of modern America is instructive of the type of environmental impacts we may expect from AV technology.

As American suburbia developed in the 1950s following the post-World War II housing boom and the construction of the interstate highway system, cities began to expand their footprint geographically faster than they grew in population. Land use policy such as single-use zoning encouraged urban sprawl, as legal restrictions on mixing commercial and residential building use in the same area resulted in further outward expansion of commuter settlements with more businesses and inhabitants migrating to them. At the same time, those who could not afford an automobile were hindered by inadequate public transportation options, inhibiting access to these outward migrations and employment opportunities. Minorities were particularly affected due in part to prohibitive zoning regulations and private restrictive covenants that excluded them from accessing these communities and opportunities. For the most part, the diversification of suburbs in contemporary America has yet to occur. Browner, *supra*, at 3. Importantly, the impacts of urban sprawl on the built environment are inextricably linked to the natural environment.

Urban sprawl is associated with adverse environmental impacts. City development patterns that require automobile use produce more air pollutants than development patterns that include alternative transportation options. David B. Resnik, *Urban Sprawl, Smart Growth, and Deliberative Democracy*, 100 Am. J. Pub. Health 1852, 1853 (2010). Automobiles are a leading source of air pollution, which incidentally disproportionately affects low-income communities of color. Urban sprawl also has adverse impacts on both water quantity and quality. Communities may face water shortages as forests are replaced with large areas of impervious surfaces that decrease rainfall absorption into groundwater aquifers. More impervious surface also means an increase in non-point source pollution from sediment from poorly managed construction sites as well as grease, oil, and other toxic chemicals from parking lots, roadways, and other surfaces. Howard Frumkin, *Urban Sprawl and Public Health*, 117 Pub. Health Rpt. 201, 206 (2002). In addition, urban sprawl disrupts critical ecosystems and wildlife habitat, threatening many imperiled species. Rein Ewing et al., *Endangered by Sprawl: How Runaway Development Threatens America's Wildlife* 1 (Nat'l Wildlife Fed'n et al., ed., 2005).

Widespread adoption of AVs could stimulate additional urban sprawl, as commuters could use driving time to engage in other activities (such as work). James M. Anderson et al., *Rand Corp., Autonomous Vehicle Technology: A Guide for Policymakers* 18 (2016). As was the case with traditional automobiles, it is likely that additional urban sprawl could compound the adverse impacts to the built and natural environment, with increased miles traveled and inefficient land use and development.

However, AVs are expected to reduce both road lane width and the need for parking in core urban areas, as Level 5 AVs could either pilot themselves to a remote area after use or, if part of an autonomous ride-share or taxi fleet, simply drop passengers off and pick up the next with no need to park. Julia Thayne, Director of Urban Development at North American Center for Cities at Siemens, points out that "in Los Angeles County, for example, 14 percent (roughly 665 square miles or 13 City of San Franciscos) of all land is devoted to parked cars. 665 square miles! Can you imagine how many parks, houses, businesses, and public transit networks could be built on just a fraction of that land?" Telephone Interview with Julia Thayne, Dir. of Urban Dev., N. Am. Ctr. for Cities at Siemens (Sept. 19, 2016). With the right policies in place, freeing up land (often brownfields) previously used for wider roads, surface parking lots, and parking structures could lead to denser city centers with additional green space and decrease the development of greenfields and sprawl.

Impacts of AV on Traditional Environmental Policies and Recommended Policy Changes

The emergence of AV technology may have increased both benefits and costs associated with a number of important federal environmental policy initiatives. At least five initiatives that policy makers need to consider when assessing the impacts of AVs on the environment include (1) smart growth, (2) mobile source planning for ozone nonattainment, (3) urban brownfield policies, (4) renewable energy policies, and (5) environmental justice. This section recommends changes to these five initiatives in order to anticipate and account for potential AV impacts to the environment.

Smart Growth. The current approach to federal and state environmental regulation is often confined to one medium (e.g., water, air, solid waste). Rather than analyze the impacts of AV technology on each of these programs in isolation, smart growth should be used to examine comprehensively the impacts of AV technology across all existing environmental programs.

Smart growth, a doctrine formulated by the American

Planning Association in 2002, covers a range of conservation strategies that help protect human health and the environment while making communities more attractive and socially diverse. According to the Environmental Protection Agency (EPA), smart growth promotes efficient and sustainable land development by optimizing the use of prior infrastructure investments and minimizing the footprint of the developed land. EPA promotes the use of smart growth for addressing climate change, water quality, brownfield redevelopment, and open space conservation.

The projected advancement of AV technology within the next two decades will be an important factor for states to consider during their SIP planning.

The smart-growth initiative should include a requirement that city planners consider the impacts of AV technology on public transportation, parking requirements, and local street systems. City planners can use smart-growth techniques to consider how to encourage brownfield redevelopment in the face of AV technology and how to avoid the potential adverse impacts of increased miles traveled on land use and development. In addition, local officials using smart growth should consider developing special zoning requirements to anticipate the potential negative effects that large, centralized fleet operations and servicing areas may have on surrounding communities. Finally, municipalities will have to rethink parking requirements for commercial and residential developments in local zoning ordinances in order to maximize efficient land use as the need for parking lots and structures decreases.

Mobile Source Planning for Ozone Nonattainment. Developing state implementation plans (SIPs) is an important requirement under the Clean Air Act (CAA) for meeting the national ambient air quality standards (NAAQS). Transportation measures can be key components of SIP development, depending on the severity of nonattainment in a geographical or urban area. If the various transportation-related activities, programs, and strategies are included in a SIP, these voluntary measures become enforceable under federal law. The projected advancement of AV technology within the next two decades will be an important factor for states to consider during their SIP planning, given the long time horizon required for NAAQS attainment requirements. The potential effects of AV technology on such planning may be particularly important in light of the new, more stringent ozone standard EPA finalized in 2015 reducing the primary and secondary ozone standard from 75 parts per billion (ppb) to 70 ppb, which is expected to increase significantly the number of areas designated as nonattainment.

Some of the policy questions that EPA and state mobile source experts will need to consider in SIP planning include whether AV could increase the number of vehicle miles traveled, and, if so, how to appropriately counteract this increase; how to ensure that AV technology encourages the use of more efficient vehicles; whether advancing the use of AV technology will reduce emissions because of more efficient traffic movements; whether the ability to interface with automated traffic controls will produce less emissions from idling at controlled intersections; whether fewer parking demands and the use of a centralized fleet will result in less mobile source emissions; and how AV technology will impact the use of mass transit and total emissions from mobile sources for SIP planning purposes.

In its proposed SIP released May 17, 2016, California was one of the first states to consider the impact of AVs on mobile source planning. California's proposed SIP includes provisions to promote and use efficiency gains related to vehicle miles traveled through the use of AV technology. The proposed SIP indicates that 80 percent of the reductions needed to meet the ozone standard in 2031 will come from regulatory actions and assumes that the remaining 20 percent will come from additional efforts to enhance the deployment of cleaner technologies through new incentive funding, efficiency improvements, and advanced transportation technologies such as AV. Cal. Envtl. Prot. Agency, *Proposed 2016 State Strategy for the State Implementation Plan* 5, 38 (May 17, 2016).

Other states must follow California's example of anticipating the effects of AV technology on mobile source planning. Though California is on the right track, its proposed SIP fails to address the effects AV technology may have on public transportation. It is imperative that states consider the interplay between AV technology and public transportation so that they can identify adequate strategies to prevent air quality deterioration.

Urban Brownfield Redevelopment. AV technology may also have a significant impact on the demand for urban brownfield redevelopment. In 1995, EPA developed a brownfield policy known as the Brownfields Action Agenda to help facilitate the redevelopment of contaminated property, which can be difficult to redevelop due to potentially exorbitant costs. The Small Business Liability Relief and Brownfield Revitalization Act, signed into law in 2002, includes grants, and, to a limited extent, liability exemptions for qualified parties. To further incentivize the redevelopment of brownfields, states also have provided a variety of state exemptions for liabilities associated with contaminated properties. Brownfields located in centralized urban areas are attractive to developers, given the increasing demand for urban living as millennials break from the white picket fence ideal in the suburbs and flock instead to the "historic brownstone stoop in the heart of the city." *Millennials Prefer Cities to Suburbs, Subways to Driveways*, Nielsen (Mar. 4, 2014). As AV fleets owned by companies such as Uber and Lyft or municipalities decrease the need for private ownership of vehicles, the amount of parking lots and structures needed in urban city centers will likely decrease, allowing for additional development opportunities.

Federal and state brownfield experts must consider how emerging AV technology will impact the demand for urban living and the redevelopment of brownfields. Will AV technology further increase demand for urban living and free up land previously dedicated to parking? Conversely, if AV technology results in more urban sprawl, will AVs decrease the demand for reuse of these contaminated urban sites and make redevelopment more difficult?

Traditional brownfield redevelopment policies will have to adapt to the anticipated opportunities in order to further incentivize redevelopment and discourage additional sprawl. In particular, fewer parking needs in city centers may increase the ability and desire to redevelop surface parking lots and parking structures that frequently act as caps to contaminated properties. Alternatively, if urban sprawl increases, the demand for rural development could increase, causing a downturn in demand for redevelopment of brownfield sites in urban areas. Thoughtful planning will allow municipalities to capitalize on the potentially positive impacts of AV technology on efficient land use.

Tax Incentives and Renewable Energy Policies. Federal and state policy makers designing tax incentive programs for certain types of renewable energy vehicles will also need to consider the impact of AV technology on the future of such programs.

Presently, there are several federal tax policies associated with energy efficient vehicles. I.R.C. § 30D provides a credit for qualified plug-in electric drive motor vehicles, including passenger vehicles and light trucks. All electric and plug-in hybrid cars purchased after 2010 may be eligible for a federal income tax credit of up to $7,500. The credit amount varies based on the capacity of the battery used to power the vehicle. However, there is a phase-out period for the manufacturer after it has sold 200,000 eligible plug-in electric vehicles. Federal law also authorized a tax credit until December 31, 2016, for electric vehicle charging supply equipment. If the charging station is considered personal property, the tax credit is the lesser of 30 percent of the station's cost or $1,000. If the charging station is considered business property, the credit is worth the lesser of 30 percent of the station's cost or $30,000. In addition to these federal tax opportunities, numerous states also have provided incentives for hybrid electric vehicles.

Policy makers and others in the renewable energy sector must consider how emerging AV technology will affect tax incentives and renewable energy policies. Will electric charging stations and/or compressed natural gas stations be more efficient since they will be located at centralized facilities owned by mass fleet operators where such vehicles will be available on demand by users and automatically returned to such facilities? Will electric utilities with centralized base load facilities be better suited to encourage electric vehicles at those centralized locations near load centers? Will a whole new industry of renewable energy be fostered by centralized owners/operators of AV fleets available on demand? In particular, will renewable energy sources associated with centralized fueling locations be an important emerging development as AV technology improves in the market place? How will all of these factors affect the current tax and grant incentives focused on electric hybrid and charging stations?

Tax incentives and renewable energy policies should account for the massive opportunity to enable and accelerate the transition to electric and other alternative fuel vehicles. For example, the current Renewable Fuel Standard, which requires that certain volumes of renewable fuel be used as transportation, home heating, and/or jet fuel each year, could be modified to account for future AV fuel needs, as well as additional renewable energy sources. As large fleet operators will have greater opportunities for centralized fueling stations, such policies could incentivize the use of renewable energy sources, such as solar, biodigester technology, or pyrolysis, for these fueling stations.

Environmental Justice. Using history as a guide, certain populations may be more likely than others to be adversely impacted by emerging AV technology. In 1994, President Clinton adopted Executive Order 12898, which requires federal actions to address environmental justice in minority populations and low-income communities. Exec. Order No. 12,898, 3 C.F.R., 1994 Comp., p. 859, *reprinted as amended in* 42 U.S.C. § 4321 app. at 278–80 (2012). The purpose of environmental justice is to identify disproportionately high, adverse environmental and human health effects of federal actions on minority and low-income populations, with the goal of achieving a more equitable environmental protection for all communities.

Policy makers must consider the potential adverse effects of AVs on particular communities. If AV technology actually encourages urban sprawl, will it have a disparate impact on low-income communities of color as automobile advancements did in the twentieth century? If AV technology will be cost prohibitive for low-income communities, how can we adapt current mass transit models to incorporate AV technology? Will the affordability of land and the need for centralized locations cause large fleet operators to locate centralized facilities near disadvantaged communities, exacerbating the adverse impacts of mobile source emissions already experienced by these communities and further decreasing land values in these areas?

Future environmental policy must anticipate the potential unintended consequences that AV technology may have on particular communities. These impacts may be positive for some populations, while negative for others. For example, AV technology is already expected to positively affect the lifestyle and needs of senior citizens, who will suddenly have more opportunity for independent mobility. On the other hand, however, AV technology has the potential to isolate further certain communities, as it did in the twentieth century when many of the expressways were routed through low-income and minority neighborhoods, effectively leveling communities and "creating disconnections from opportunity that exist to this day." Ashley Halsey III, *A crusade to defeat the legacy of highways rammed through poor neighborhoods*, Wash. Post (Mar. 29, 2016), *available at* www.washingtonpost.com/local/trafficandcommuting/defeating-the-legacy-of-highways-rammed-through-poor-neighborhoods/2016/03/28/ffcfb5ae-f2a1-11e5-a61f-e9c95c06edca_story.html.

Policy makers must consider how we can steer clear of repeating this history. In part, policy makers can do so by using smart growth techniques to assess the potential effects of adopting AV technology on certain vulnerable populations. As part of this effort, it is imperative that we develop policies and governance that allow public transportation operators to adapt current mass transit schemes with AV technology in mind so that public transportation operators can play an active role in delivering cost-effective, high-quality public transportation.

In a *Washington Post* interview, U.S. Secretary of Transportation Anthony Foxx noted that "[t]ransportation for a long time has been seen in the light of something that is connected to opportunity." *Id.* Careful consideration and diligent planning that contemplate lessons learned from the past can make this next AV transportation revolution an opportunity for all communities, while also minimizing the impact to the built and natural environment.