Connected, Automated, Zero-Emission Cars Are Essential for Improving Livable, Sustainable Communities

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ABSTRACT

One of the public policy goals for livable and sustainable communities is to minimize the use of automobiles. This paper focuses on introducing and justifying an important new policy principle. Even when car travel is minimized with smart growth land development policies, transportation demand management, and increased public transit, a significant level of automobile use will remain. As a result, reducing the environmental, economic and safety impacts of those remaining automobiles should be an essential element of a livable, sustainable community. Fortunately, fundamental and disruptive technological advances in new vehicles—automation, connectivity, and electrification—as described in this paper are fast emerging to make this new priority feasible.

KEY WORDS

livability, sustainability, smart growth, electrified vehicles, automated driving, connected vehicles, personalized mobility, traffic safety, smart cities, urban planning

One of the shared public policy goals for the two concepts of livable and sustainable communities is to minimize the use of automobiles (1). This paper focuses on introducing and justifying an important new policy principle: Even while car travel is reduced with smart growth land development policies, transportation demand management, and strong public transit, reducing the harmful environmental, economic and safety impacts of the remaining and irreducible vehicle use is essential – not optional, not merely desirable, but essential -- for livable and sustainable communities.

The U.S. Government supports livable communities through the Partnership for Sustainable Communities formed in June 2009 by the U.S. Department of Housing and Urban Development (HUD), the U.S. Department of Transportation (DOT), and the U.S. Environmental Protection Agency (EPA). As described by the Federal Highway Administration, “These three agencies have pledged to ensure that housing and transportation goals are met while simultaneously protecting the environment, promoting equitable development, and helping to address the challenges of climate change” (2). The Graham Environmental Sustainability Institute at the University of Michigan defines "livable communities" as "places that seek to balance economic and natural assets to meet the diverse needs of local residents in the present and in the future. These communities offer a variety of housing choices, convenient transportation options, healthy lifestyle options, reduced air and water pollution, and protection of natural landscapes. These communities also allow people to live closer to jobs and save money on personal transportation” (3).

As part of a Graham Institute-funded integrated assessment of innovative and disruptive vehicle technologies, a partnership of the University of Michigan Connected Vehicle Proving Center (CVPC) and the Center for Advanced Transportation and Energy Solutions (CATES) has explored the hypothesis that the broad deployment of cars with electric motors for oil-free propulsion, wireless data connectivity, and automation applications for driver assistance and eventual autonomous vehicle control is essential to the growth in the livability and sustainability in U.S. communities. This hypothesis has not been previously advanced to date, based on evidence from existing programs (4). This paper provides support for the hypothesis.

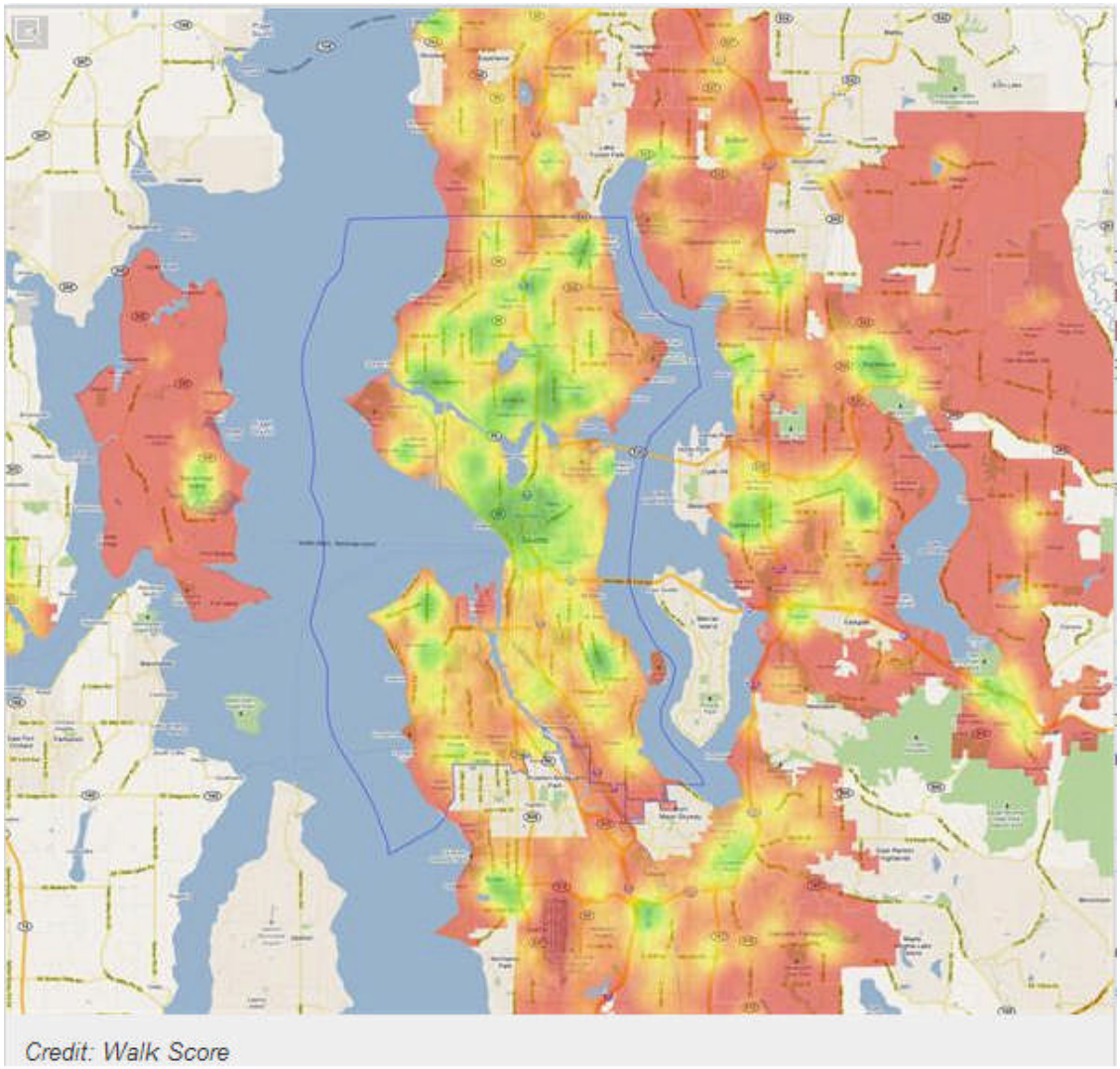
Because the design of livable, sustainable communities seeks to reduce automobile use by residents and visitors, the hypothesis is counterintuitive and perhaps surprising. As noted by the first Secretary of Transportation in the Obama Administration, Ray LaHood, "Livability means being able to take your kids to school, go to work, see a doctor, drop by the grocery or post office, go out to dinner and a movie, and play with your kids at the park - all without having to get in your car" (5).

SEATTLE AS AN EXAMPLE

Although the need to use a car may be minimized within a livable community, the experience in such communities to date is that cars still drive into and through the geographic extent of livable places that have roads.

An example of a U.S. city that strives to have livable, walkable neighborhoods is Seattle, Washington. Figure 1 is a map from Walk Score showing the high walkability of many neighborhoods in this city, depicted in green.

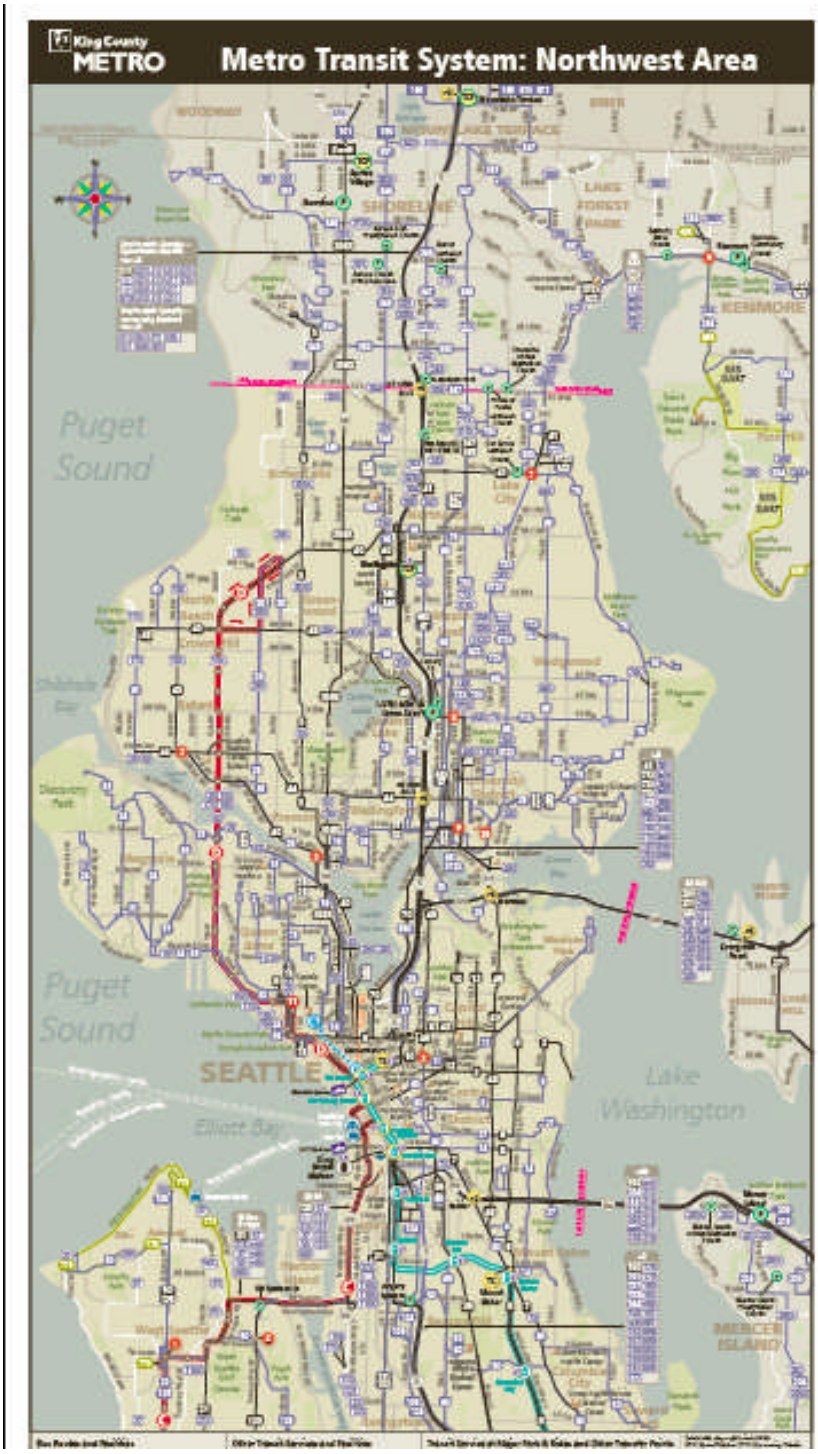
Figure 1: Walkable Neighborhoods of Seattle, Washington Shown in Green



Map from http://www.walkscore.com

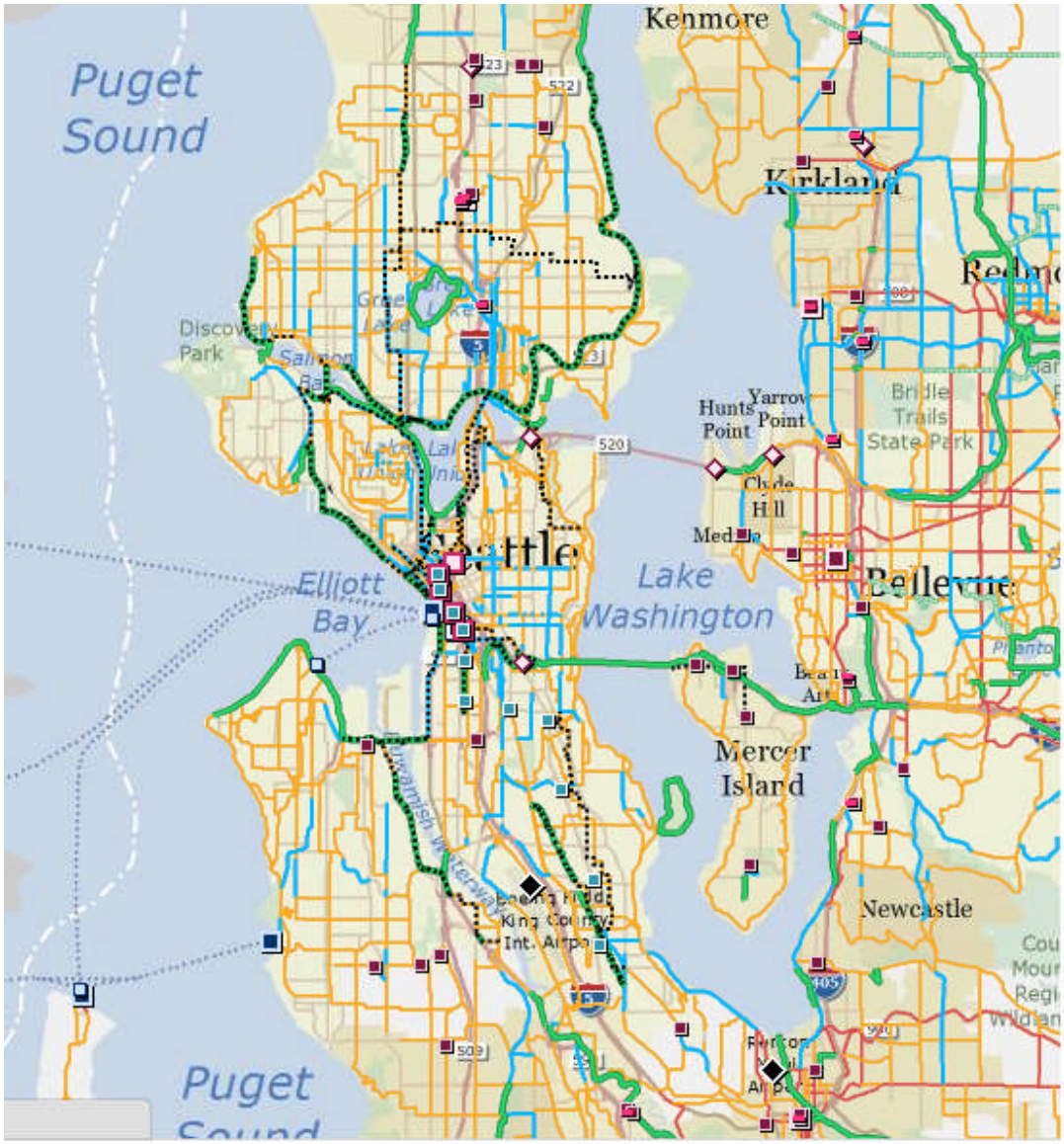
For moving around without a car, Seattle has ubiquitous public transit (Fig 2) and an extensive bike lane network (Fig 3).

Figure 2: Public Transit Routes in Seattle, Washington



Map from King County Metro

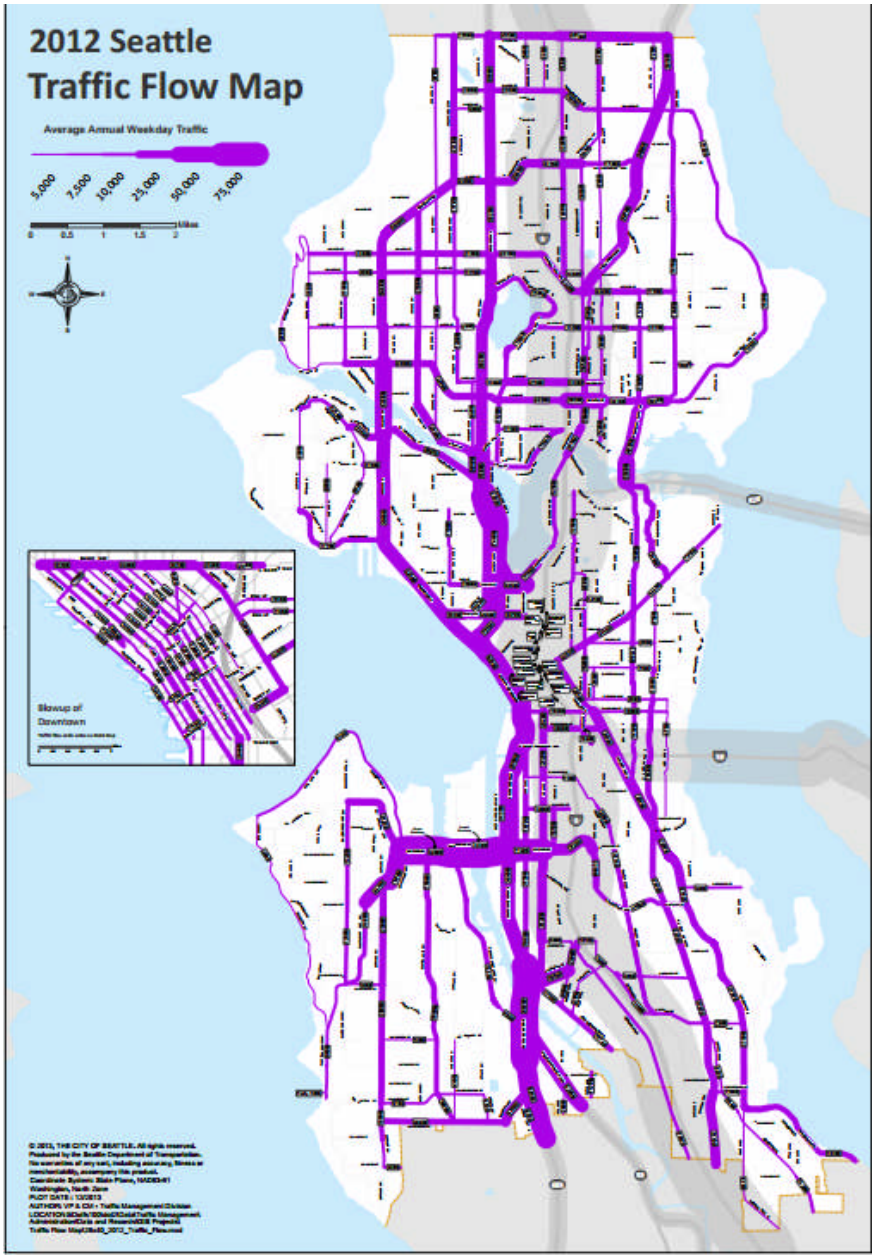
Figure 3: Bicycle Lanes and Paths in Seattle, Washington



Map from King County Geographic Information Services

Furthermore, parking at the curb throughout the city is controlled with time-metered pricing or residential permit requirements. Still, the Seattle Department of Transportation map of traffic volumes on roads throughout the city (Fig 4) illustrates that massive traffic flows are always close to or in some cases passing through walkable neighborhoods.

Figure 4: Daily Vehicle Volumes in Seattle, Washington



Map from City of Seattle Department of Transportation

As long as significant car usage continues, how cars affect the environment remains pertinent to livability. Cars now and in the future are likely to provide a large share of the mobility in and between livable communities, as frequently noted by veteran transportation analysts (6).

Or consider the example of the entire four-county Seattle-Tacoma region. The creation of dense, transit-oriented livable communities is a major priority in the public spending and policies of the Metropolitan Transportation Plan of the Puget Sound Regional Council (PSRC), a plan that

prescribes government resource allocation to transportation programs out to year 2040. However, even with the emphasis on livability and half of all government spending on transportation allocated to public transit including a doubling of bus service, PSRC's computer modeling of future travel demand forecasts the mode share of automobile use in trip making at 82.4% in 2040 (7).

Even considering the frequently observed ongoing decline in per capita miles of driving in North America over the past decade (8), there is no doubt from even the lowest car usage forecast scenarios that automobiles will remain a dominant mode for surface travel in urban environments and elsewhere (9).

Therefore, it is important to recognize and reduce the many present ways in which cars cause environmental damage that detracts from sustainability and the impacts that reduce livability. These impacts are several, to be described next. Fortunately, harm reduction in each area is in sight from new technology applications.

ENVIRONMENTAL DAMAGE FROM AUTOMOBILES, AND SOLUTIONS

A first and prominent negative impact of cars comes from the air emissions produced by the petroleum-burning internal combustion engines found in the majority of today's cars. These emissions are approximately proportional to the amount of petroleum fuel burned (10). Harmful air emissions include the six EPA-regulated pollutants plus greenhouse gases (GHG). These local emissions are now recognized as causing premature deaths at the same rate as car crashes (11).

Fortunately, a switch from petroleum fueled engines to zero-emission electric motors is an increasingly available power train option. Plug-in hybrids and battery-only electric car sales are growing rapidly, currently doubling year over year (12). Along with improvements in internal combustion engines, an increase in the proportion of cars using batteries and electric motors for propulsion reduces air emissions. The reduction of the need to use increasingly expensive petroleum fuels is another community economic benefit of automobility that trades out gas station fill ups for plug-in recharging at home, at work, in shopping centers, and at other common destinations or roadside stops.

The U.S. Government has mandated higher fuel economy in cars and light trucks, which is forecast by a recent National Academy of Science panel to be an important step to reduce air emissions, along with improvements in internal combustion engines and new fuels like natural gas and biofuels, plus evolution of the electric power grid to zero carbon. (13). The new 54.5 miles per gallon Corporate Average Fuel Economy (CAFÉ) standard for 2025, along with emission control rules at the multi-state level following the leadership from California is going to force car makers to produce and sell more cars that are electric powered (14). A further benefit of electric cars is their quietness compared to cars with internal combustion engines, so quiet that government is intervening to make sure they make some noise for the sake of safety (15).

A second obvious negative impact of cars is fatalities, injuries, and property damage from traffic accidents of all sorts. 33,561 drivers, passengers, pedestrians, and cyclists died in 2012 in motor

vehicle mishaps in the U.S. There were 2.36 million serious injuries. Costs from vehicle accidents exceed $70 billion per year. Vehicle crashes are the leading cause of death for Americans aged 11 through 27. According to the NHTSA, most mishaps involve driver error or incapacitation (16).

But thanks to development of computers, software, and sensors over the past decade, the prospect is now at hand for vehicle automation to substantially reduce vehicle mishaps large and small. This was clearly revealed by industry presentations at the Transportation Research Board (TRB) Road Vehicle Automation Workshops in July 2012 and July 2013 (17), and has been affirmed by the National Highway Traffic Safety Administration (NHTSA) in a policy statement (18). Cars with automation capabilities – such as lane-keeping and automatic braking – are going to be increasingly deployed over the course of the decade just ahead, with capabilities by the mid 2020s for periods of no-hands, no-feet, safe driving.

Automation technology has already been developed and deployed by some manufacturers that keeps cars from colliding with other vehicles, with bicycles, and with pedestrians (19), as well as lane-keeping to prevent vehicles leaving the roadway. How fast this technology deploys onto the streets of USA is dependent upon its price to end users, as influenced by incentives and regulations from governments, suggesting an important public policy role.

A third negative impact from autos is the extensive occupation of street space and parking lot space by cars, manifested in the worst case as traffic congestion and packed parking lots, which typically occupy an average of about half the land area in urban commercial development (20). Advanced vehicle automation provides the capability of reducing street traffic and parking demand in communities where leaders are seeking livability.

First of all, automation to the extent that cars can move autonomously to new locations could mean fewer cars needing parking. But even if the number of cars used does not decrease with expansion of automation, there is the prospect of taking some parking capacity in dense areas out of service because automated cars can be parked closer together or in lots that are less proximate to walkable, livable community zones. Outside of parking, simply reducing the number of vehicle collisions removes a significant cause of road congestion. Automation of vehicles also supports smoother driving patterns in vehicles with internal combustion engines, which improves energy efficiency and thus reduces air emissions (21).

At the same time, vehicle automation opens up the potential for improving the performance and sustainability of public transit, a signature element of livable urban communities. Automation of vehicle control yields new options for reducing the cost of transit operations by offering mobility with a lower requirement for highly skilled human operators than has been the traditional pattern. Vehicle automation also provides opportunity for new forms of transit – for example, driver-less, multi-passenger shuttles making multiple trips with no driver salary cost – that could efficiently serve lower density suburban residential zones better than fixed route buses (22).

Automated vehicles have capabilities that fit well with the denser residential zones characteristic of smart growth and livability. Speed limits can be electronically maintained and enforced. Electric urban vehicles can be smaller and lighter, thus more compatible with narrow streets and

less space dedicated to parking. Increased opportunity for shared vehicle use and non-owned multi-passenger shuttle vans could also potentially lead to fewer vehicles requiring parking (17). These are all potentials that will require public policy guidance.

In summary, new vehicle technology in motor cars with associated new capabilities such as car sharing, ride sharing, and driverless transit, could potentially take down air pollution, GHG emissions, crashes, traffic congestion, and parking space. All of these issues are on the list that sustainable, livable communities try to deal with by reducing vehicle ownership and car use. In a future scenario where some level of car use remains in livable communities, new vehicle technologies in the residual vehicles can reduce the same negative impacts that reducing the number of vehicles per capita addresses.

CONCERNS AND CONCLUSION

Concerns have been raised that future autonomous driving that lets drivers do other things besides paying attention to the road while on daily commuting trips could make cars more popular at the expense of public transit. This might make sprawling land use more attractive by facilitating easy, comfortable travel in cars that are safer and greener. In response we would note that smart growth is often well incentivized by land use controls, the rising cost of travel from fuel prices, and provision of urban amenities that support higher density residential zones.

At the same time, suburbanization continues to expand (23) inexorably even with the automobile fleet in very early stages of electrification and automation. The safety and GHG reduction benefits that accrue from the expanded deployment of new vehicle technologies are compelling and may come to enlarge the popular definition of livability to include safer, cleaner, more comfortable motorized personal mobility when it is desirable, such as in family trips during off-peak periods.

Whether cars become more attractive or less attractive in any segment of a community, they are still going to be a major mode of travel even if motor car use were to end up decades from now at half or less of today's levels. Outside of livability programs, widely-accepted public policy steps are being taken to lower the damage that cars do to the climate and to people on the planet, no matter where people live.

For this reason plus the inevitable ubiquity of cars in all American communities, we conclude that the expanded deployment of clean, safe cars is not benign and neutral in the context of livability and sustainability, but rather essential. This is true for those who reside in livable communities of intentionally dense design with convenient transit service, and as well, obviously, for everybody else.

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