Sustainable Healthy Cities

JOURNAL BRIEF: Estimating Adoption of Electric, Autonomous, and Shared Vehicle Technologies in the United States

Sustainable Healthy Cities Journal Brief - 2018, No. 7 Electric, Autonomous, and Shared Vehicle Adoption

This brief is adapted from the following articles submitted for peer review:

-Quarles, N. & K.M Kockelman. (Forthcoming). America's Fleet Evolution in an Automated Future. Under review for publication in *Transportation Research Part D.*
-Quarles, N. & K.M. Kockelman. (Forthcoming). America's Plans for Acquiring and Using Electric Shared and Self-Driving Vehicles. Under review for publication in *Transportation Research Record*.
-Gurumurthy, K.M. & K.M. Kockelman. (Forthcoming). Modeling Americans' Autonomous Vehicle Preferences: A Focus on Dynamic Ride-Sharing, Privacy, & Long Distance Mode Choices. Under review for publication in *Transportation Research Part C*.

Study Intent and Research Question

With the ongoing advancement of electric, autonomous, and shared vehicle technologies, how readily will Americans adopt these technologies, and what are their opinions towards them? A survey of 1,426 adult Americans gauges their interest in and intentions to adopt these technologies, as well as opinions on related policies.

Additionally, evolution of the United States vehicle fleet is simulated until year 2050. Multiple scenarios, calibrated with the survey results, are considered to forecast adoption and the vehicle miles traveled (VMT) produced by each technology. An additional survey of 2,588 Americans is also conducted to better understand autonomous vehicle travel preferences.

Key Background Information

Electric vehicles (EVs) have the potential to drastically reduce negative effects associated with emissions, perhaps by as much as half, in many existing power generation settings (Reiter and Kockelman 2017). EV owners may also benefit by saving money over operating internal combustion vehicles, especially if employing overnight charging (Tonachel 2017).

Autonomous vehicles (AVs) may bring forth safety advantages, while simultaneously lowering emissions and congestion externalities, by providing smoother driving than human counterparts (Fagnant and Kockelman 2014). These benefits will be dependent on the technology's influence on VMT. AVs may also revolutionize shared vehicle markets by combining the two technologies in the form of shared autonomous vehicles (SAVs), which may impact vehicle ownership rates and mode share for all forms of travel.

Previous studies have conducted surveys covering many aspects of these technologies and examined fleet evolution with an emphasis on some of the technologies considered here. However, they have not comprehensively considered these technologies together in a fleet simulation based on recent survey results.

Key Findings

AV AND SAV FINDINGS

Respondents believe AVs (both privately-held and SAVs) should be allowed to travel empty roughly 20% of the time. Approximately a quarter of respondents would like empty AV travel banned.

AVs and SAVs may capture nearly 50% of future trips under 500 miles. A majority of these trips are likely to be business trips.

Respondents indicate very little willingness to share SAV rides with strangers if it increases their travel time by more than five minutes, and little willingness to share rides at night. However, a trip's location being broadcasted to family may increase their willingness to choose SAVs.

Roughly one third of respondents would prefer an AV to a human-driven vehicle for their next purchase, and the average respondent would use AV mode for just over a third of their travel if in a vehicle capable of both.

The average willingness to pay for SAVs is $0.44 per mile, and the mode may gain widespread popularity at around $0.75 per mile. larger, guarded areas being able to support healthier soil ecosystems.

EV FINDINGS
Respondents still show a willingness to own an EV if they lack charging access at work, but not if they lack charging access at home.

All else equal, charge time is found to be a major factor in expected EV adoption rates for a vehicle with a 200-mile range.

FLEET EVOLUTION RESULTS
In the fleet evolution simulation, the ability to retain a human-driven option is found to significantly increase AV adoption rates, while the rate of technology price decline also influences adoption.

The simulation shows a negligible change in the average distance a household lives from the city center after AVs and SAVs become more widely available.

Hybrid and plug-in hybrid vehicle adoption rates grow dramatically, with each comprising roughly 40% of the U.S. fleet by 2050 at the expense of gasoline-powered share of the fleet, while battery-electric adoption grows relatively slowly.

Policy and Practice Implications

AV AND SAV IMPLICATIONS
Regulators will likely need to limit empty AV travel to a level below that preferred by the average American if they are to prevent AV availability from increasing congestion.

Policymakers will also need to determine whether the potential negative effects associated with allowing AVs to be sold with a human-driving option outweigh potential benefits from the increased adoption rates this could produce.

Understanding the likely price decline of AV technology will allow governments and manufacturers to better prepare for their adoption by more accurately estimating the rate at which it will occur.

The low willingness to share SAV rides with strangers may pose congestion problems, since riders won't often combine their VMT.

The low willingness to forgo vehicle ownership may limit the land use benefits of SAVs because large quantities of land will still be required for any privately-held vehicles (automated or otherwise).

Policy must be put in place for the ethical implications behind AV-related crashes.

EV IMPLICATIONS
Increasing the availability of fast chargers and advancing battery technology that supports faster charging could be pivotal in allowing battery-electric vehicles to capture significant market share.

Adding public charging capability in residential areas where residents may lack home charging access (such as neighborhoods with high rental rates and multi-family housing) may be crucial to growing EV adoption among this portion of the population.

Transportation

Policy & Governance

Behavior Change

Further Reading and References

Fagnant, Daniel; Kockelman, Kara M. (2014) The Travel and Environmental Implications of Shared Autonomous Vehicles, Using Agent-Based Model Scenarios. Transportation Research Part C 40:1-13.

Reiter, Matthew S.; Kockelman, Kara M. (2017) Emissions and Exposure Costs of Electric Versus Conventional Vehicles: A Case Study for Texas. International Journal of Sustainable Transportation 11 (7): 486-492.

Tonachel, Luke (2017) Electric Vehicles Can Benefit all Utility Customers. National Resource Defense Council. Accessed on February 19, 2017 at: https://www.nrdc.org/experts/luke-tonachel/electric-vehicles-can-benefit-all-utility-customers

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About the Sustainable Healthy Cities Network

The Sustainable Healthy Cities Network is a U.S. National Science Foundation supported sustainability research network focused on the scientific advancement of integrated urban infrastructure solutions for environmentally sustainable, healthy, and livable cities. We are a network of scientists, industry leaders, and policy partners, committed to building better cities through innovations in infrastructure design, technology and policy. Our network connects across nine research universities, major metropolitan cities in the U.S. and India, as well as infrastructure firms, and policy groups to bridge research and education with concrete action in cities.

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