The electrification accelerator: Understanding the implications of autonomous vehicles for electric utilities

Jürgen Weiss\textsuperscript{a,}\textsuperscript{⁎}, Ryan Hledik\textsuperscript{b}, Roger Lueken\textsuperscript{c}, Tony Lee\textsuperscript{a}, Will Gorman\textsuperscript{d}

\textsuperscript{a} The Brattle Group, One Beacon Street, Suite 2600, Boston, MA, 02108, USA
\textsuperscript{b} The Brattle Group, 8th Floor Aldernary House, 10-15 Queen Street, London, EC4N 1TX, United Kingdom
\textsuperscript{c} The Brattle Group, 1800 M Street NW, Suite 700 North, Washington DC, 20036, USA
\textsuperscript{d} Energy and Resources Group, University of California, Berkeley, USA

\textbf{ARTICLE INFO}

\textbf{Keywords:}
Electrification
Electric vehicle
Autonomous vehicle
Electric utility
Rate design
Regulation

\textbf{ABSTRACT}

The intersection of autonomous vehicles, ride sharing and transportation electrification could have significant implications for electric utilities. This paper analyses how the development of shared autonomous electric vehicles may make electrification more likely and why this may lead to a more rapid than expected shift in the current transportation paradigm. We also discuss how these trends may affect utilities and suggest what they can do to prepare for the transition.

1. Introduction

Rapid advancements in autonomous vehicle (AV) technology, combined with the growth of ride hailing and vehicle sharing, are creating the possibility of a radical transformation of transportation. In parallel, progress in the development of electric transportation is causing electric utility companies to analyze how their business models may need to change to accommodate electric vehicles (EVs). To date, utility studies have tended to focus on a scenario of relatively gradual adoption of EVs replacing individually owned non-electric vehicles. Those studies have not fully considered the impact that automation and ride/vehicle sharing might have on the speed of electrification of transportation and the associated opportunities and challenges for electric utilities.

This article focuses on the intersection of autonomous vehicles, ride sharing/ride hailing, and electric vehicles and the implication these phenomena may have for the utility business model. We begin by briefly introducing AV technologies and ride/vehicle sharing concepts and discussing how the development of shared autonomous electric vehicles (SAEVs) may make electrification more likely. We then explain why this may lead to a more rapid than expected shift in the current transportation paradigm. We conclude with a discussion of how these trends may affect utilities and suggest what they can do to prepare for the transition.\textsuperscript{1}

2. Autonomous vehicles and the sharing economy

Recent years have seen massive investments in autonomous driving technology by automobile manufacturers, ride sharing software companies, and technology companies. Autonomous vehicles are being promoted as a way to increase safety, driver comfort, and vehicle efficiency. The expected benefits include reduced accident and fatality rates, reduced traffic congestion, expanded access of mobility to currently underserved populations, and reduced space use in urban areas.\textsuperscript{2}

\textsuperscript{⁎} Corresponding author.
\textsuperscript{1} This short paper does not discuss the benefits of electric transportation for utilities and in terms of reduced GHG emissions. For a discussion of these issues, see Jurgen Weiss, Ryan Hledik, Michael Hagerty, and Will Gorman, Electrification – Emerging Opportunities for Utility Growth, January 2017. Available at: http://www.brattle.com/system/news/pdfs/000/001/174/original/Electrification_Whitepaper_Final_Single_Pages.pdf

https://doi.org/10.1016/j.tej.2017.11.009
Several companies have already commercially deployed technology with varying levels of autonomy.\footnote{There are several levels of autonomy, typically classified as Level 1 to Level 5 (full autonomy). We focus on the implications of Level 5 autonomous vehicles. Many car makers have already introduced models with lower levels of autonomy, such as adaptive cruise control and self-parking (Level 1) and Tesla’s Autopilot feature (Level 2).\footnote{Many terms are being used to describe various product offerings. We use the term car sharing to identify situations where the same vehicle is sequentially shared by different drivers and/or passengers. Ride sharing refers to situations where different users share the same car at the same time as a passenger, essentially as a taxi substitute. The distinction between the two loses relevance with driverless cars, since all trips are essentially being undertaken in passenger mode, which is why our term SAEV (shared autonomous electric vehicle) covers both services. SAEVs can be used in single occupancy or multiple occupancy mode.}}

At the same time, growth in ride sharing and car sharing services\footnote{Bruce Schaller, Unsustainable? – The Growth of App-Based Ride Services and Traffic, Travel and the Future of New York City, Feb. 27, 2017. Available at schaller-consult.com/rideservices/unsustainable.pdf.} is also quickly transforming how consumers use transportation, particularly in urban areas. In the past three years, use of on-demand ride sharing services (such as Uber and Lyft) in New York City has doubled annually and is now approaching yellow cab ridership levels.\footnote{Susan Shaheen and Adam Cohen, Innovative Mobility Carsharing Outlook, Transportation Sustainability Research Center, Winter 2016. Available at http://innovativemobility.org/wp-content/uploads/2016/02/Innovative-Mobility-Industry-Outlook_World-2016-Final.pdf.} Similarly, membership in car-sharing programs (such as Zipcar and Car2Go) increased by 34% from 2012 to 2014 in North America to over 1.6 million members.\footnote{Princeton researchers have found that Uber drivers spend more time and drive a higher share of miles with a passenger in their car than do taxi drivers across several U.S. cities. Shared AVs could have even higher utilization than ride-sharing vehicles today due to reduced traffic congestion and improved vehicle coordination and dispatch. See Judd Cramer & Alan B. Krueger, 2016, Disruptive Change in the Taxi Business: The Case of Uber, American Economic Review, Vol 106(5), pages 177-182. Available at http://www.uber.org/papers/w22083?utm_campaign=mtk&utm_medium=email&utm_source=ntw.\footnote{Uber launched a test fleet of partially automated internal combustion vehicles in Pittsburgh in August 2016, while Lyft has partnered with General Motors to test automated electric vehicles in 2017. (a) See: http://www.wsj.com/articles/gm-lyft-to-test-self-driving-electric-taxi-1462460994?accesed=15 November 2017. (b) See: http://www.csmonitor.com/Business/In-Gear/2016/1009/How-are-Uber-s-self-driving-cars-doing-in-Pittsburgh?accessed=15 Nov 2017.)}

Automation technology has the potential to leverage the “sharing economy” by creating an optimized network of shared vehicles and thus vastly improving the overall value of transportation services. Automated ride sharing could significantly reduce per-mile transportation costs and emissions and increase vehicle utilization by matching cars for hire with passengers traveling in similar directions.\footnote{Buyers trade higher upfront costs for lower running costs over time. See: https://www.edmunds.com/electric-car/ (accessed 15 Nov 2017).} This in turn could make personal vehicle ownership the exception rather than the rule, at least in densely populated urban areas. The potential benefits of this transition are evidenced by ambitious AV sharing programs being piloted across the country by Uber, Google, and others.\footnote{Uber launched a test fleet of partially automated internal combustion vehicles in Pittsburgh in August 2016, while Lyft has partnered with General Motors to test automated electric vehicles in 2017. (a) See: http://www.wsj.com/articles/gm-lyft-to-test-self-driving-electric-taxi-1462460994?accesed=15 November 2017. (b) See: http://www.csmonitor.com/Business/In-Gear/2016/1009/How-are-Uber-s-self-driving-cars-doing-in-Pittsburgh?accessed=15 Nov 2017.)}

### 3. Automation as an accelerator of electrification

In addition to potential improvements in safety, convenience, and efficiency, shared AVs may disrupt the economy in another way: by rapidly expediting the transition to transportation electrification. There are several reasons to believe the emergence of shared AVs could accelerate the adoption of EVs.\footnote{Jonathan Walker and Charlie Johnson, Peak Car Ownership: The Growth of App-Based Ride Services and the Market Opportunity of Electric Automated Mobility Services, Rocky Mountain Institute, 2016. Available at http://www.rmi.org/peak_car_ownership.}

AVs deployed to provide mobility services could favor EVs due to advantages in cost of ownership. In the near term, EVs will likely continue to be characterized by a higher purchase price, but lower operating costs relative to internal combustion engine vehicles.\footnote{The average amount of time spent in a vehicle is approximately one hour per day for the average U.S. individual. See: “Summary of Travel Trends: 2009 National Household Travel Survey,” Federal Highway Administration. Available at http://nhts.ornl.gov/2009/pub/stt.pdf.\footnote{The average U.S. resident drove an average of 10,874 miles annually in 2014 and 2015. See: American Driving Survey: 2014–2015, AAA Foundation for Traffic Safety, September 2016. Available at https://www.aaafoundation.org/sites/default/files/AmericanDrivingSurvey2015.pdf.\footnote{Jens Hagman et al. Total cost of ownership and its potential implications for battery electric vehicle diffusion, Research in Transportation Business & Management 18 (March 2016): 11–17.}}\footnote{Many terms are being used to describe various product offerings. We use the term car sharing to identify situations where the same vehicle is sequentially shared by different drivers and/or passengers. Ride sharing refers to situations where different users share the same car at the same time as a passenger, essentially as a taxi substitute. The distinction between the two loses relevance with driverless cars, since all trips are essentially being undertaken in passenger mode, which is why our term SAEV (shared autonomous electric vehicle) covers both services. SAEVs can be used in single occupancy or multiple occupancy mode.} At higher levels of annual vehicle miles traveled, lower operating costs lead to cumulative savings that offset a higher upfront EV purchase price. Many individual consumers drive too few miles to reach this threshold. The average car is driven 11,000 miles per year and parked and left idle for more than 90% of the time.\footnote{National Task Force on Ridesharing, 1979. See: http://www.presidency.ucsb.edu/les/source = ntw.\footnote{The average amount of time spent in a vehicle is approximately one hour per day for the average U.S. individual. See: “Summary of Travel Trends: 2009 National Household Travel Survey,” Federal Highway Administration. Available at http://nhts.ornl.gov/2009/pub/stt.pdf.\footnote{The average U.S. resident drove an average of 10,874 miles annually in 2014 and 2015. See: American Driving Survey: 2014–2015, AAA Foundation for Traffic Safety, September 2016. Available at https://www.aaafoundation.org/sites/default/files/AmericanDrivingSurvey2015.pdf.\footnote{Jens Hagman et al. Total cost of ownership and its potential implications for battery electric vehicle diffusion, Research in Transportation Business & Management 18 (March 2016): 11–17.}}\footnote{Many terms are being used to describe various product offerings. We use the term car sharing to identify situations where the same vehicle is sequentially shared by different drivers and/or passengers. Ride sharing refers to situations where different users share the same car at the same time as a passenger, essentially as a taxi substitute. The distinction between the two loses relevance with driverless cars, since all trips are essentially being undertaken in passenger mode, which is why our term SAEV (shared autonomous electric vehicle) covers both services. SAEVs can be used in single occupancy or multiple occupancy mode.}}
دریافت فوری
متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات