POWERING THE MOBILITY REVOLUTION

The Case for Integrating Vehicle Electrification & Batteries into Strategies to Promote Autonomous Vehicles

I|E|I
INSTITUTE FOR ENERGY INNOVATION

INTRODUCTION

Mobility – the movement of people and goods – is changing rapidly as the pace of technological innovation continues to accelerate. Mobility, technology, and energy are increasingly interwoven as the transportation sector becomes more connected, more autonomous, and more shared, particularly in urban environments. And all of this change will enable more people to get around.

Importantly, these autonomous, connected, and shared vehicles are increasingly also electrifed. Driven by rapid declines in battery costs which have driven down overall electric vehicle (EV) prices, as well as the benefits of EVs in meeting both the power demands of connected vehicles and the engineering requirements of connected and autonomous vehicles (CAVs), global automakers and ridesharing service providers are increasingly turning to electric drivetrains as the platform of choice to drive the mobility revolution.

Despite this growing nexus between connected and autonomous vehicles and EVs, however, many states' mobility strategies are not well-aligned with the battery and vehicle electrification strategies necessary to take full advantage of this convergence. As a result, those states risk losing out on market share and industry clustering to states that embrace a more comprehensive, coordinated strategy that fully integrates batteries and EVs into mobility-releated economic development strategies. To make the most of the business opportunities associated with CAVs, states must consider how the vehicles of the future will be fueled or charged, and what technological, policy, and infrastructure advancements are needed to support this platform.

Using Michigan as an example, this paper considers the growth of advanced mobility, and the role of vehicle electrification and battery development in the deployment of connected, autonomous, and shared vehicles. It then outlines a series of policy, infrastructure, community outreach, and industry recommendations to align state strategies around batteries, EVs, and advanced mobility. This paper is not intended to address the numerous issues connected to the rapid development of the advanced mobility sector, but does attempt to paint a picture of the potential future innovations in the advanced transportation industry and the role of vehicle electrification in delivering on the promise of mobility solutions. [1]

---

[1] *The themes addressed in this paper were also the focus of the Institute for Energy Innovation's 4th annual Michigan Energy Future Conference, Powering Mobility, which was held on September 25, 2017, at the College for Creative Studies in Detroit, Michigan. The event, featuring speakers in the automotive, charging, and energy storage industries – as well as utility representatives, regulators, and policymakers – considered how these groups can work together to enable the connected, autonomous, shared, and electrified future of mobility.*

TRANSFORMATION

THE EMERGENCE OF A NEW MOBILITY INDUSTRY

The growth of CAVs has the potential to transform the transportation industry. Already we are seeing the beginnings of a rapid development of self-driving vehicles and mobility solutions across the United States. The different types of technology driving the mobility revolution was recently covered by the Center for Automotive Research (CAR) in a report entitled Future Cities: Navigating the New Era of Mobility. In the report, CAR provides the following definitions for connected vehicles and autonomous vehicles:

> Connected Vehicle (CV) Systems – Any system enabling the exchange of digital information between a vehicle and the world (e.g. another vehicle, infrastructure). Vehicles can connect in multiple ways: vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I) and vehicle-to-everything (V2X).
>
> Automated Vehicle (AV) Systems – Any electronic system that influences the lateral or longitudinal operation (or both) of a ground vehicle.[1]

CAR also notes that "some vehicles could be connected without being automated, and possibly others could be automated without being connected, automotive manufacturers are increasingly aiming to develop vehicles that are both automated and connected.[2]

Notably, the level of autonomy can (and does) vary greatly, with levels of autonomy ranging from driver assistance, which is standard in most new cars (e.g., lane and parking assist), to full self-driving capability.

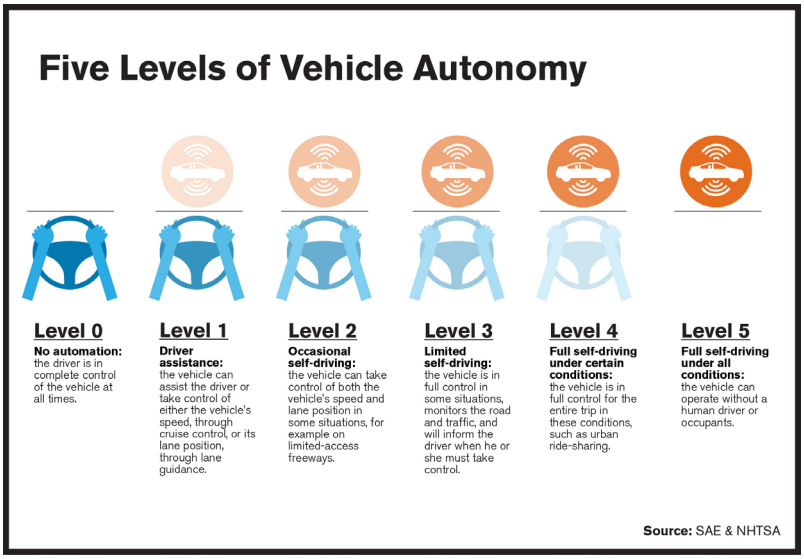

Figure 1. The Five Levels of Vehicle Autonomy.[3]

This growth in self-driving vehicles has the potential to dramatically change how consumers use vehicles. It also has the potential to completely disrupt the existing vehicle industry, as well as create whole new industries and value chains. We can expect to see a move from personal vehicle ownership to shared vehicles, particularly in urban areas. This means that, rather than investing in a privately-owned vehicle, an individual can pay per mile traveled in a shared vehicle, ultimately getting more value out of their investment.

Another advantage of the adoption of autonomous vehicles is increased accessibility to consumers. Autonomous vehicles can help with commutes, errands, transporting children to activities, and, all the while, allow for ride-sharing when not in use. These vehicles of the future will spend less time sitting idle, and, as a result, will be much more efficient in their transportation outcomes. As a result of giving mobility to new populations, including the elderly, disabled people, and other non-drivers, many studies find that the growth CAVs will not actually decrease vehicle miles traveled, though it could reduce the number of vehicles sold.[4,5]

Further, because they eliminate the possibility of human error that accounts for so many automobile accidents, autonomous vehicles are likely to be safer.[6] According to CityLab, "Last year the National Safety Council (NSC) reported over 35,000 Americans lost their lives in traffic crashes. According to a 2015 National Highway Traffic Safety Administration (NHTSA) report, 94% of crashes are caused by human error. Drunk driving, distractions, drowsiness, and speeding are major contributing factors. Automated vehicles help with crash avoidance."[7] Indeed, the NHTSA estimates that ad full adoption, CAVS could prevent up to 615,000 crashes, 418,000 injuries, and 1366 deaths (approximately 3 percent of annual fatalities) each year.[8]

THE GROWTH OF ELECTRIC VEHICLES AND DECLINING BATTERY COSTS

Even apart from their connection with AVs, consumers are increasingly seeking out fuel-efficient vehicles, with 2017 U.S. EV sales 30% higher than in 2016.[9] That could grow even higher, as a recent Navigant report projects EV sales to be 50% higher in 2017 than in 2016.[10] These trends are only likely to accelerate. A report by Bloomberg New Energy Finance predicts that EVs will outsell gasoline models by 2040,[11] and also increased their projections by more than 50% over just last year, showing growing confidence in the global EV market.

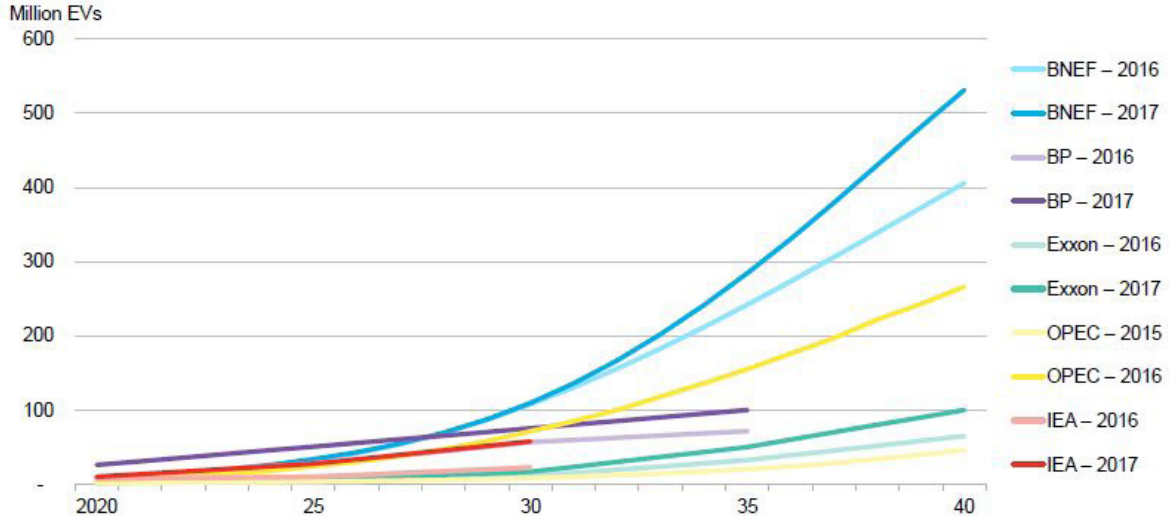

Figure 2. 2017 Forecasts for Global EV fleet ramp up. [12]

Seeing opportunities in this sector, there has been an explosion in EV choice in recent years, with most leading automotive original equipment manufacturers (OEMs) offering or planning to offer a range of new EV models. In October, General Motors announced plans to introduce 20 new all-electric cars by 2023, including two new EVs within the next 18 months.[13] Ford announced that it would add 13 new EVs over several years, with a planned five-year investment of $4.5 billion.[14] Already, three companies are offering models that combine affordability with a 200+ mile range. This list includes the Chevy Bolt, the second-generation Nissan Leaf, and the Tesla Model 3. In addition, a number of automakers have signaled their intention to move completely into the EV space. General Motors' October annoucnement of new EV lines also included a pledge to work towards an "all-electric future." Other OEMs have announced similar goals, with Volvo planning to electrify its entire vehicle line by 2019, Jaguar Land Rover by 2020, and Mercedes-Benz by 2022. [15]

This growth is driven by the increasing cost competitiveness of EVs with internal combustion engine (ICE) vehicles. Bloomberg New Energy Finance predicts that EVs will cost less than conventional vehicles by 2025, largely due to the rapid decline in battery costs and increases in storage densities – creating a virtuous cycle that makes batteries and EVs increasingly attractive and affordable.[16] Another recent report from Bloomberg New Energy Finance shows that battery costs declined 24% between 2016 and 2017, and have declined nearly 90% just since 2010.

Figure 3. Steep and continuing declines in battery costs.[17]

EVs are already cheaper to operate due to reduced maintenance costs and the cost advantages of electric charging over petroleum as a vehicle fuel. According to the U.S. Department of Energy, the cost of electricity equivalent to a gallon of gasoline is approximately $1/eGallon, compared with current gasoline costs of approximately $2.50/ gallon. As a result, EVs are already often cheaper on a cost-per-mile basis than ICE vehicles. What's more, electricity is diverse and domestic, it offers greater price-stability than oil, and the power sector has spare capacity and an existing network of infrastructure.[18] These advantages in both cost and predictability provide measurable benefits, particularly to owners and operators of vehicle fleets.

A recent report from Rocky Mountain Institute (RMI) compared a Base 2017 Toyota Camry to a Base 2018 Tesla Model 3 to demonstrate the money saved through lower fuel costs and lower maintenance costs by switching to an EV. According to RMI's research, the release of affordable, long-range Evs this year makes 2017 a tipping point in terms of the cost savings associated with switching from an internal combustion engine vehicle to an EV.

COST PER MILE OF GASOLINE AND ELECTRIC SERVICE SEDANS

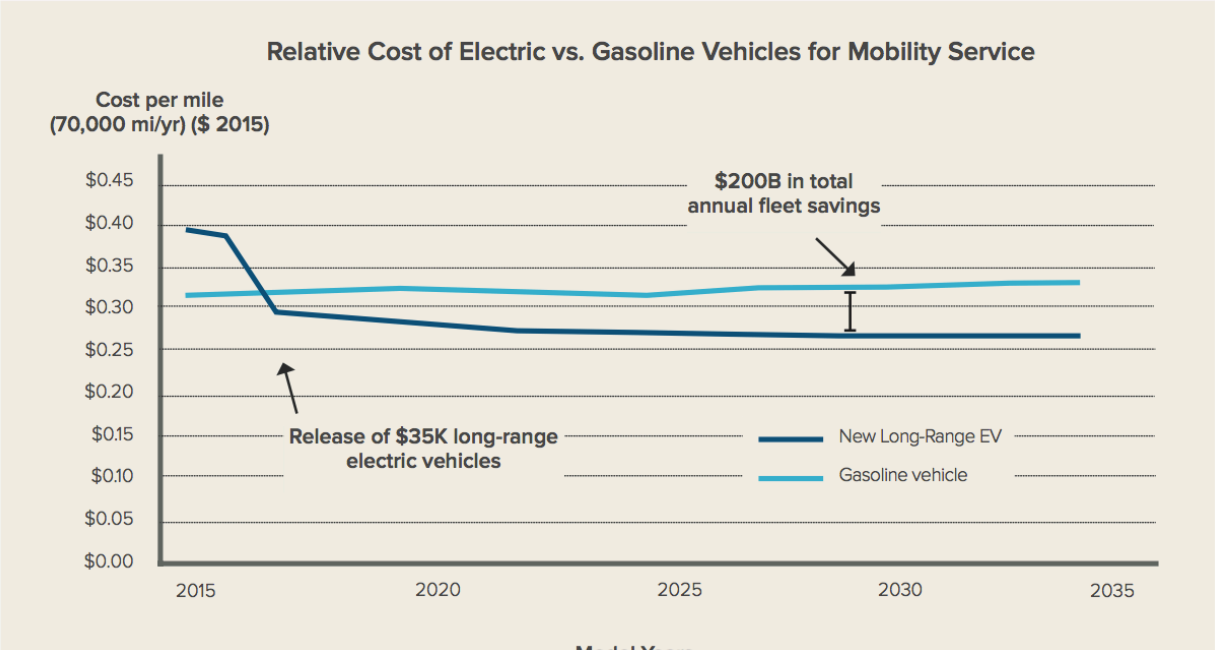

Figure 4. Cost per mile for electric and gas service sedans.[19]

Notably, the base price of $35,000 for both the Chevy Bolt and the Tesla Model 3 does not account for the Federal Purchase Incentive of up to $7,500 for plug-in hybrid electric vehilces (PHEVs) and battery electric vehicles (BEVs) sold after 2010. The credit varies based on the battery used to power the vehicle (kWh), and will begin to phase out to 50% of the full credit amount once a manufacturer has reached 200,000 PHEVs and BEVs sold.[20]

THE CONVERGENCE OF ADVANCED MOBILITY AND VEHICLE ELECTRIFICATION

As noted above, there is a growing nexus between mobility solutions and vehicle electrification. As the Center for Automotive Research (CAR) noted in its recent report Future Cities: Navigating the New Era of Mobility, "a combination of engineering, operational, regulatory, and marketing factors are making some companies consider using electric vehicles for their self-driving models."[21] This reflects a similar conclusion of the U.S Department of Energy, which found that there are a number of technological advantages to an electric drivetrain relative to that of an internal combustion engine for connected and autonomous vehicles.[22] Autonomous vehicles require electricity to power their telecommunication and data management features, and electric drivetrains offer additional advantages in acceleration and deceleration for connected and self-driving vehicles. Put simply, it is easier for computers to drive EVs because they have fewer moving parts and the main components – battery, inverter, and electric motor – more easily communicate with each other in EVs.[23] Further, most EVs are configured for electric drive, steering, and brake systems that are structurally more compatible with automated driving than systems found in internal combustion engines.[24]

As a result of these advantages, major vehicle OEMs and ride sharing service providers are increasingly turning to vehicle electrification as a platform for mobility services. For example, Tesla has been making plans for fully autonomous driving,[25] putting autopilot programs in every vehicle.[26] Meanwhile General Motors owns and operates the startup company Maven, which focuses on mobility-as-a-service rather than car manufacturing. Maven is a short-term car rental service, for ride-as-you-go usage, using General Motors and Chevrolet vehicles.[27] Maven users borrow cars for personal needs as well as professional "gigs" (Maven's term for work opportunities) including rideshare and delivery driving.[28]

Maven's current services allow users in certain geographies to essentially test-drive the company's electric Chevy Bolt and grow more comfortable with the concept of driving an EV. As Rachel Bhattacharya, Chief Growth Officer, explained in her talk at the MEC4: Powering Mobility conference, Maven's "gig" drivers become impressed that they can survive a full day of drop-offs and pick-ups, charge when needed, and never run out of fuel or miss out on jobs. In fact, "gig" drivers charge during breaks and lunch, and rather than concerns about downtime during recharge, the reverse played out and drivers were faced with too few charging stations. Personal drivers also have become comfortable taking the EVs on longer-range trips: Bhattacharya cited one customer who drove over 1,200 miles from Los Angeles, California, to Portland, Oregon, in a Bolt. This demonstrates that experience with Evs is helping customers overcome range anxiety.[29] Along with other ridesharing companies like Lyft and Uber, Maven is at the forefront of future mobility solutions.

Maven's Rachel Bhattacharya speaks at the MEC4: Powering Mobility Conference.

Similarly, Ford has rebranded itself as not solely a car company, but rather as a multi-faceted mobility company – working on projects in vehicle electrification, shared electric bicycle services, and shared electric car services. To continue to guide the company down this new path, Ford promoted Smart Mobility Chief Jim Hackett to CEO earlier this year.[30] From May 2015 through November 2016, Ford piloted a car-sharing programcalled GoDrive in

London. The service primarily operated from private parking spaces, on a hub system that allowed drivers to return cars to a different, pre-determined location. The car-sharing service offered London residents flexible, practical, and affordable one-way trips with guaranteed parking, operated with a pay-as-you-go smartphone app. The program used Ford Focus electric cars and fuel-efficient Ford Fiesta 1.0-litre EcoBoost cars. Through the pilot Ford found that the customers in the program responded positively to EVs, and enjoyed the convenience of easy, one-way transportation.[31]

Finally, Ford pledged $200 million earlier this year for an advanced data center to support the company's expansion to an auto and mobility company, and the expected dramatic increase in data storage.[32]

Yet the transition to EVs is not guaranteed. According to a National Renewable Energy Laboratory (NREL) study on EV adoption in Colorado, "consumer access to a robust network of publically accessible charging stations is vital to increased EV adoption."[33] Consumers need easy-to-access charging infrastructure to feel comfortable buying and driving EVs, but utilities and site hosts do not want to install charging infrastructure without an existing demand for it. This "chicken and egg" problem has plagued EV adoption. However, as Chris Nelder of the Rocky Mountain Institute (RMI) pointed out at the MEC4: Powering Mobility conference, previewing RMI's October report From Gas to Grid, this problem is disappearing thanks to "a fast-growing fleet of increasingly affordable EVs that consumers love".[34] Indeed, "[w]ith electric vehicles coming on fast thanks to undeniable advantages in the cost of ownership and the driving experience itself, it's time to move on from the old debates about when the EV revolution will arrive. It's here."[35] Put more directly, "vehicle electrification isn't an if or a when question anymore; it's only a question of How fast? and Can we be ready in time?"[36]

To meet this challenge, states must ensure they have sufficient EV charging deployment so that it does not become the bottleneck to EV deployment, particularly as EVs and CAVs continues to converge. As Britta Gross, Director of Advanced Vehicle Commercialization Policy for General Motors, stated in recent comments to the MPSC, "[t]he speed with which EV charging can be expanded will determine the pace of EV adoption in Michigan as well as the ability to drive even more advanced transportation technologies."[37] Specifically, "EV infrastructure is also key to developing innovative and advanced mobility solutions in Michigan, such as car-sharing, ride-hailing, and autonomous vehicles. The ability to introduce and grow these advanced mobility services relies on a robust foundation of EV charging infrastructure."[38]

What these experts are saying is that a lack of public charging infrastructure could significantly interfere with the deployment of mobility services. In order to fully leverage the opportunities the mobility revolution represents, states must integrate vehicle electrification and charging strategies with mobility planning, and do so with a sense of urgency.

COMBINING VEHICLE ELECTRIFICATION & MOBILITY IN MICHIGAN

Michigan is aggressively positioning itself to lead in global mobility ecosystem through development and deployment of connected and autonomous vehicles. As the birthplace of the auto industry, Michigan's automotive leaders are key players in this industry transition over a century later. Michigan-based automotive manufacturers are not only competing with other automakers to lead the global market, but also with technology and innovation players who are completely changing the traditional paradigm of what it means to be a transportation company. The focus of the Detroit OEMs and other key players is how to build the runway to an advanced mobility future. If Michigan fails to lead on this, its leadership of the automotive industry is at-risk.

Recognizing this, leaders in both the public and private sectors, with significant participation from universities and NGOs, have worked to build an integrated mobility ecosystem to ensure Michigan remains on the cutting edge in the development and deployment of CAVs. As CAR notes in its recent Future Cities report, "Michigan has been the site of significant state- and federally-supported [connected vehicle] CV research and testing initiatives," including the U.S. Department of Transportation-funded CV Proof of Concept in the Novi/ Farmington Hills area in 2005; the Ann Arbor Safety Pilot Model Deployment (SPMD) led by the University of Michigan Transportation Research Institute (UMTRI) with support from the Michigan Department of Transportation (MDOT) and the Michigan Economic Development Corporation (MEDC); and the Ann Arbor Connected Vehicle Test Environment currently being conducted by UMTRI.[39]

Michigan is also home to leaders in automated transportation innovation, including the the University of Michigan's Mcity, a 32-acre testing ground launched in 2015 that features the country's "first purpose-built CAV test facility with simulated urban and suburban driving environments,"[40] and the American Center for Mobility, a partnership between MDOT, MEDC, and other partners, that is one of the first organizations in the nation working on an automated vehicle testing ground,[41] a facility of more than 500 acres that will be completed in 2018 at the historic Willow Run site in Ypsilanti.[42] In addition, a team of researchers at the University of Michigan won a $1.5 million grant from ARPA-E's NEXTCAR program for solutions related to autonomous vehicles across a range of power platforms.[43] The University of Michigan will also offer electric driverless shuttles to transport students around campus starting in 2018.[44] Automakers are deeply involved in these efforts, and Ford this month announced plans to invest $900 million and create 850 jobs as it works to transform its Flat Rock manufacturing plant into "an AV center of excellence," with plans to launch an autonomous vehicle at scale by 2021.[45]

At the policy level, Michigan leads in developing appropriate legislative and regulatory frameworks for CAVs. Michigan is one of just six states that allow self-driving vehicles on public roads. In 2016, Governor Rick Snyder signed legislation allowing for the operation of autonomous vehicles on state roadways to create an innovation-friendly environment.[46] "Michigan put the world on wheels and now we are leading the way in transforming the auto industry," Governor Snyder said. "We are becoming the mobility industry, shaped around technology that makes us more aware and safer as we're driving. By recognizing that and aligning our state's policies as new technology is developed, we will continue as the leader the

rest of the world sees as its biggest competition."[47] The 2016 statutory changes, which built on 2013 legislation that allowed for the testing of prototyped automated vehicles on public roads under certain conditions,[48] also created the Michigan Council on Future Mobility, which features an innovative charter to maintain leadership through annual review and recommendation on additional legislative and regulatory approaches.

Michigan is also driving mobility-related policy development at the federal level. Michigan Senator Gary Peters and Congresswoman Debbie Dingell co-chair the Senate Smart Transportation Caucus and the House Smart Transportation Caucus, respectively. Both Senator Peters and Senator Debbie Stabenow are co-sponsors of S. 1885, the American Vision for Safer Transportation Through Advancement of Revolutionary Technologies (AV START) Act, which is currently pending on the Senate floor. On the House side, the House passed H.R. 3388, the Safely Ensuring Lives Future Deployment and Research In Vehicle Evolution (SELF DRIVE) Act in October, which included Representatives Fred Upton (R-MI 06), Tim Walberg (R-MI 07), and Debbie Dingell (D-MI 12) as co-sponsors.

Senator Gary Peters speaks at the MEC4: Powering Mobility Conference.

In addition to leading in innovation and policy development relating to advanced mobility, Michigan also features strengths in EV manufacturing and advanced batteries. The advanced storage industry is rooted in Michigan and partnerships have been built between the battery industry and other industries in the emerging advanced transportation sector.[49] Michigan is the home of battery-pack manufacturing, advanced-battery vehicle research, engineering, development and integration, and establishment of a fully integrated, large-format cell manufacturing facility.[50] Michigan investments supported by the federal government in advanced battery and EV manufacturing and development fueled the sector,[51] as well as unique public-private partnerships like the University of Michigan Energy Institute's Battery Fabrication and Characterization User Facility and the General Motors/ University of

Michigan Advanced Battery Coalition for Drivetrains. Through these investments, Michigan has emerged as a global leader in the advanced energy storage sector.

Michigan also continues to pioneer vehicle electrification strategies, and Michigan automotive manufacturers are also stepping up their production of EVs, often in concert with mobility strategies. In 2015, for example, General Motors added 1200 workers to ramp up production of the Chevy Volt and other models at its Detroit-Hamtramck plant.[52] More recently, General Motors began production this year of the next generation of its autonomous test vehicles on the Bolt all-electric platform at its Orion Township assembly plant.[53]

However, while the domestic auto industry continues to push forward to expand EV manufacturing, other regions are moving even faster, and last year, for the first time, China supplied more than half of the world's EVs.[54]

RECOMMENDATIONS

With its strengths in batteries, vehicle electrification, and connected and autonomous vehicles, Michigan is uniquely well positioned to leverage the convergence of these sectors to unlock significant economic benefits. To aid in the deployment of electric advanced mobility solutions, Michigan should integrate efforts around advanced batteries and EVs into strategies to promote mobility.

Specifically, this report offers four recommendations to better align the state's EV and battery strengths with mobility initiatives in order to fully realize the economic development potential around advanced mobility:

1. Expand the Michigan Council on Future Mobility created by Public Act 332 of 2016 to include specific expertise in EVs, batteries, and EV infrastructure;

2. Accelerate regulatory strategies to expand EV charging infrastructure and reduce barriers to deployment, including removing barriers to offering charging as a service;

3. Reconvene the Michigan Plug-In Electric Vehicle Preparedness Taskforce at the Michigan Public Service Commission to convene utilities, vehicle OEMs, mobility service providers, third-party charging companies, and other stakeholders to address EV charging issues, with a particular focus on the nexus between EVs and advanced mobility; and

4. Establish an internal state government coordinating group with all relevant agencies including Michigan Department of Transportation, Michigan Agency for Energy, Michigan Economic Development Corporation, Michigan Department of Environmental Quality and potentially othersto align battery, EV, and mobility economic development efforts.

Each of these recommendations is addressed in turn.

1. EXPAND THE MICHIGAN COUNCIL ON FUTURE MOBILITY TO INCLUDE SPECIFIC EXPERTISE IN EVS, BATTERIES, AND EV INFRASTRUCTURE

As previously noted, Public Act 332 of 2016 established the Michigan Council on Future Mobility, which is charged with providing "recommendations for changes in state policy to ensure that this state continues to be the world leader in autonomous, driverless, and connected vehicle technology."[55] The Council is co-chaired by MDOT Director Kirk Steudle and John Perachhio, Managing Partner of Perachhio and Company, LLC, and is comprised of twelve additional individuals with specific areas of expertise relating to connected and autonomous vehicles, as well as four legislators and the heads of a number of state agencies. Adding an individual with specific expertise in EVs, batteries, and EV infrastructure would help ensure that Michigan is anticipating the infrastructure needs required to power vehicles that are connected, autonomous, shared, and electric and avoids a situation where a lack of charging serves as a bottleneck that frustrates the deployment of such vehicles.

2. REVISIT REGULATORY STRATEGIES AROUND EVS TO EXPAND EV CHARGING INFRASTRUCTURE AND REDUCE BARRIERS TO DEPLOYMENT

States interested in leading in the mobility revolution should connect EV growth with the necessary charging infrastructure to support it. This includes widespread deployment of EV charging stations, grid upgrades, and implementation of advanced meters. According to the Electrification Coalition, "Drivers are accustomed to being able to fill up using the ubiquitous gasoline infrastructure developed over the last 100 years. Inability to do so will generate significant hesitancy— range anxiety—for many drivers".[56] It's difficult to overstate the importance of available charging infrastructure in overcoming range anxiety issues that frustrate EV deployment. In Kansas City, for example, EV sales grew 95% after a local utility launched the country's largest car charging network in 2015.[57]

In addition, faster charges are needed to allow customers to charge up quickly and continue driving.[58] As such, public charging infrastructure will necessarily carry a higher voltage than home charging infrastructure. However, the high upfront cost for installing high voltage chargers can inhibit potential site hosts from making the investment while the EV fleet is still small.[59] This can be addressed through a variety of incentives for patient investment. Particularly for expensive direct current fast charge (DCFC) stations, utility involvement can help scale the availability of charging options. Other financing solutions including municipal bonds and green bonds, long-duration purchase agreements, and green bank investments to make the upfront investment worthwhile for site hosts.[60]

Utility rate design also has the potential to dramatically shape the economics of charging – both for better and for worse. Dynamic rates and time of use rates are still needed to enable the right signals to ensure that EV charging is done when the grid has excess capacity. Careful attention to demand charges is also necessary to avoid charging premiums that inadvertently create barriers to workplace charging.

3. RECONVENE THE MICHIGAN PLUG-IN ELECTRIC VEHICLE PREPAREDNESS TASKFORCE TO ADDRESS EV CHARGING ISSUES, WITH A PARTICULAR FOCUS ON THE NEXUS BETWEEN EVS AND ADVANCED MOBILITY;

Beginning in 2008, the Michigan Public Service Commission convened the Plug-In Electric Vehicle Preparedness Taskforce to bring together a range of interested stakeholders, including automotive OEMs, utilities, state and local government, electrical contractors, and others, on a broad range of issues affecting EV deployment in Michigan. These issues included incentives for EV adoption, consideration of the charging infrastructure necessary to support EV deployment, revisions to state building codes affecting EV charging stations, public education and efforts to raise awareness of EVs, and other issues. The Michigan Plug-In Electric Vehicle Preparedness Taskforce effort ran through 2011.

More recently, the MPSC has invited comments from interested parties on strategies to spur EV deployment, and specifically, the appropriate role for utilities and the Commission to play in building out EV charging infrastructure. This focus on EV charging infrastructure led to an August 2017 technical conference held at the Commission to hear from a stakeholders from the automotive, utility, and charging infrastructure sectors, as well as other experts, as well as an invitation for stakeholders to submit comments regarding potential EV charging pilot programs that could be undertaken by utilities and authorized by the Commission. The Commission also has other dockets open that include issues relating to EV deployment, including an ongoing distribution planning process where MPSC staff will convene interested stakeholders and report back no later than September 1, 2018 on a framework for future distribution plans, including how to match distribution investments to the growth of EVs.

On December 20, 2017, the MPSC issued an order convening a second EV technical conference in February 2018 with the goal of developing utility pilot programs focused on four topic areas: customer education, rate design and smart charging, grid impact, and deployment of EV infrastructure. This second technical conference represents a significant step in the right direction. In addition, to ensure that this effort is ongoing, the MPSC should reconvene the Plug-In Electric Vehicle Preparedness Taskforce to inform its long-term consideration of the range of issues connected with EV deployment. As part of this effort, the Commission should invite participation from representatives of MDOT, the MEDC and others helping to shape state strategies around advanced mobility to ensure these efforts are properly coordinated with mobility-related economic development efforts.

4. ESTABLISH AN INTERNAL STATE GOVERNMENT COORDINATING GROUP TO ALIGN BATTERY, EV, AND MOBILITY ECONOMIC DEVELOPMENT EFFORTS

To ensure full integration of state strategies involving advanced mobility, batteries, and electric vehicles, state government should establish an internal coordinating group that includes the program leads for each of these sectors. Currently, mobility issues are not fully integrated with economic development efforts relating to vehicle electrification or the state's advanced battery sector. An EV/ CAV/ battery coordinating group would help connect economic development leads, identify cross-cutting issues between these sectors, and increase the opportunities for Michigan to leverage its many strengths across these industries.

CONCLUSION

The growth of connected and autonomous vehicles presents a generational opportunity for Michigan to leverage its historic strengths in automotive research, development, and manufacturing in establishing itself as a global center for advanced mobility. As the auto industry continues to move towards vehicle autonomy, vehicle electrification is the necessary next step to guarantee effective rollout of autonomous vehicles. Therefore, continued innovations in advanced energy technology vehicle elecrification are necessary for the future of advanced mobility, and, without the right policy framework, states and cities risk losing out on the benefits of this transition.

Fortunately, state policymakers and economic development officials have taken significant steps to position Michigan as a global center for mobility development. By integrating these strategies with Michigan's complimentary strengths in advanced batteries and vehicle electrification, as well as building out charging infrastructure to mitigate range anxiety and a void a lack of charging opportunities serve as a bottleneck to deployment of connected, autonomous, shared, and electric vehicles, Michigan can better ensure that it will continue to lead the development of the global EV and CAV industries.

1. Center for Automotive Research, Future Cities: Navigating the New Era of Mobility, 2017, pg. 11.

2. Id.

3. "Autonomous Vehicles Meet Human Drivers: Traffic Safety Issues for States." Governors Highway Safety Association. Accessed October 26, 2017. http://www.ghsa.org/resources/spotlight-av17.

4. "Taming the Autonomous Vehicle: A Primer for Cities." Bloomberg Philanthropies. (March 2017) p. 38-39. Accessed on October 26, 2017. https://www.bbhub.io/dotorg/sites/2/2017/05/TamingtheAutonomousVehicleSpreadsPDF.pdf.

5. Walker, Jonathan and Charlie Johnson. "Peak Car Ownership: The Market Opportunity of Electric Automated Mobility Services." Rocky Mountain Institute. (2016) p.18. Accessed on October 26, 2017. http://www.rmi.org/peak_car_ownership.

6. Thompson, Cadie. "Why Driverless Cars Will Be Safer Than Human Drivers." Business Insider. (November 2016). Accessed October 26, 2017. http://www.businessinsider.com/why-driverless-cars-will-be-safer-than-human-drivers-2016-11.

7. Small, Andrew. "The Self-Driving Dilemma." City Lab. (May 2017). Accessed October 26, 2017. https://www.citylab.com/transportation/2017/05/the-self-driving-dilemma/525171/.

8. National Highway Trafic Safety Administration, Notice of Proposed Rulemaking to Mandate Vehicle-to-Vehicle (V2V) Communication Technology for New Light Vehicles in the United States, 82 Fed. Reg. 3854 (Jan. 12, 2017) (to be codified at 49 C.F.R. pt. 571).

9. "Monthly Plug-in Sales Scorecard." Inside EVs. (October 2017). Accessed October 26, 2017. https://insideevs.com/monthly-plug-in-sales-scorecard/?utm_content=buffer82e1e&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer.

10. Market Data: EV Geographic Forecasts: Battery and Plug-In Hybrid EV Sales and Populations in North America." Navigant Research. (2017). Accessed October 26, 2017. https://www.navigantresearch.com/research/market-data-ev-geographic-forecasts.

11. Gustin, Georgina. "Electric Cars will outsell Gas Competitors by 2040, BNEF says." Inside Climate News. (July 2017). Accessed October 26, 2017. https://insideclimatenews.org/news/06072017/electric-cars-majority-bnef-forecast-volvo-batteries-scott-pruitt.

12. Cheung, Albert. "Cheung: The EV Bandwagon Is Accelerating, But Is It Unstoppable?" Bloomberg New Energy Finance. (July 2017). Accessed January 9, 2018. https://about.bnef.com/blog/cheung-ev-bandwagon-accelerating-unstoppable/.

13. Vlasic, Bill and Neal Boudette. "GM and Ford Lay Out Plans to Expand Electric Models." The New York Times. (October 2017). Accessed October 26, 2017. https://www.nytimes.com/2017/10/02/business/general-motors-electric-cars.html.

14. Id.

15. Williams, Brett. "Here's how every major automaker plans to go electric." Mashable. (Oct. 3, 2017). http://mashable.com/2017/10/03/electric-car-development-plans-ford-gm/#oWtnxdDXuiqs. Accessed October 26, 2017.

16. Davies, Alex. "The Electric Car Revolution is now scheduled for 2022." Wired. (February 2016). Accessed January 8, 2018. https://www.wired.com/2016/02/electric-car-revolution-now-scheduled-2022/

17. Chediak, Mark. "The Latest Bull Case for Electric Cars: The Cheapest Batteries Ever." Bloomberg New Energy Finance. (December 2017). Accessed January 9. 2018. https://about.bnef.com/blog/latest-bull-case-electric-cars-cheapest-batteries-ever/

18. "The Electrification Roadmap." Electrification Coalition. (November 2009). p. 11. Accessed October 26, 2017. http://www.electrificationcoalition.org/sites/default/files/SAF_1213_EC-Roadmap_v12_Online.pdf.

19. Walker, Jonathan and Charlie Johnson. "Peak Car Ownership: The Market Opportunity of Electric Automated Mobility Services." Rocky Mountain Institute. (2016) p. 10. Accessed on October 26, 2017. http://www.rmi.org/peak_car_ownership.

20. "Federal Tax Credits for All-Electric and Plug-in Hybrid Vehicles." U.S. Department of Energy. Accessed October 26, 2017. http://www.fueleconomy.gov/feg/taxevb.shtml.

21. Center for Automotive Research, Future Cities: Navigating the New Era of Mobility, 2017, pg. 11.

22. "The Transforming Mobility Ecosystem: Enabling an Energy-Efficient Future." U.S. Department of Energy. (2017) p. 18. Accessed October 26, 2017. https://energy.gov/sites/prod/files/2017/01/f34/The%20Transforming%20Mobility%20Ecosystem-Enabling%20an%20Energy%20Efficient%20Future_0117_1.pdf.

23. Gardner, Greg. "Our Autonomous Future Will Likely Be an Electric One – Here's Why." Detroit Free Press. (September 2016). Accessed on October 26, 2017. http://www.govtech.com/fs/Our-Autonomous-Future-Will-Likely-Be-an-Electric-One-Heres-Why.html.

24. Id.

25. Lambert, Fred. "Elon Musk clarifies Tesla's plan for level 5 fully autonomous driving: 2 years away from sleeing in the car." Electrek. (April 2017). Accessed October 26, 2017. https://electrek.co/2017/04/29/elon-musk-tesla-plan-level-5-full-autonomous-driving/.

26. "Full Self-Driving Hardware on all Cars." Tesla. Accessed October 26, 2017. https://www.tesla.com/autopilot.

27. "About." Maven. Accessed October 26, 2017. https://www.mavendrive.com/#!/about.

28. "Flexible Leases/Rentals for Rideshare and Delivery Drivers." Maven. Accessed October 26, 2017. https://mavengig.maven.com/us/.

29. Bhattacharya, Rachel. Overview of General Motors Urban Mobility and Maven. Keynote presentation, MEC4: Powering Mobility Conference, Detroit, September 25, 2017.

30. Stateside Staff. "Ford CEO switch mostly about stock price, culture change." Michigan Radio. (May 2017). Accessed October 26, 2017. http://michiganradio.org/post/ford-ceo-switch-mostly-about-stock-price-culture-change.

31. "Ford brings dynamic car-sharing experiment to London; first service to offer one-way trips with guaranteed parking." Ford Media Center. (May 2015). Accessed October 26, 2017. https://media.ford.com/content/fordmedia/feu/en/news/2015/05/26/ford-brings-dynamic-car-sharing-experiment-to-london--first-serv.html.

32. "Ford investing $1.2 billion in three Michigan facilities, further bolstering leadership in trucks, SUVs, mobility." Ford Media Center. (March 2017). Accessed October 26, 2017. https://media.ford.com/content/fordmedia/fna/us/en/news/2017/03/28/ford-investing-one-point-two-billion-in-three-michigan-facilities.pdf.

33. "Study Estimates Consumer Demand for Electric Vehicle Charging Stations in Colorado." National Renewable Energy Laboratory. (October 2017). Accessed October 26, 2017. https://www.nrel.gov/news/program/2017/study-estimates-consumer-demand-for-electric-vehicle-charging-stations-in-colorado.html.

34. Fitzgerald, Garrett and Chris Nelder. "From Gas to Grid." Rocky Mountain Institute. (2017). p. 10. Accessed October 26, 2017. https://www.rmi.org/wp-content/uploads/2017/10/RMI-From-Gas-To-Grid.pdf.

35. Fitzgerald, Garrett and Chris Nelder. "From Gas to Grid." Rocky Mountain Institute. (2017). p. 1. Accessed October 26, 2017. https://www.rmi.org/wp-content/uploads/2017/10/RMI-From-Gas-To-Grid.pdf.

36. Nelder, Chris. Charging and fueling the vehicles of tomorrow. Panel discussion, MEC4: Powering Mobility Conference, Detroit, September 25, 2017.

37. Gross, Britta K. "GM Comments on EV Infrastructure Deployment." Michigan Public Service Commission Case No. U-18368. Nov. 17, 2017.

38. Id.

39. Center for Automotive Research, Future Cities: Navigating the New Era of Mobility, 2017, pg. 12.

40. Center for Automotive Research, Future Cities: Navigating the New Era of Mobility, 2017, pg. 15.

41. Nagl, Kurt. "American Center for Mobility awards $24 million contract for driverless cars proving grounds." Crain's Detroit Business. (June 2017). Accessed October 26, 2017. http://www.crainsdetroit.com/article/20170615/NEWS/170619920/american-center-for-mobility-awards-24-million-contract-for?profileid=26566&view=homepage&utm_campaign=social-flow&utm_source=twitter&utm_medium=social.

42. Center for Automotive Research, Future Cities: Navigating the New Era of Mobility, 2017, pg. 15.

43. Frawley-Panyard, Nicole. "NAME Chair, Jing Sun, awarded $1.5M grant for NEXTCAR automated vehicle project." The Michigan Engineer News Center. (May 2017). Accessed October 26, 2017. https://news.engin.umich.edu/2017/05/sun-awarded-1-5m-for-nextcar/.

44. Slagter, Martin. "Driverless shuttle coming to University of Michigan's North Campus." MLive. (June 2017). Accessed October 26, 2017. http://www.mlive.com/news/ann-arbor/index.ssf/2017/06/mcity_will_offer_driverless_sh.html.

45. Martinez, Michael. "Ford EV moving to Mexico to make room for autonomous vehicles in Flat Rock," Crain's Detroit Business. Dec. 7, 2017. http://www.crainsdetroit.com/article/20171207/news/647081/ford-ev-moving-to-mexico-to-make-room-for-autonomous-vehicles-in-flat

46. "Gov. Rick Snyder signs landmark legislation to allow operation of autonomous vehicles on Michigan roadways." Office of Governor Rick Snyder. (December 2016). Accessed October 26, 2017. http://www.michigan.gov/snyder/0,4668,7-277--399173--,00.html.

47. Id.

48. See 2013 Public Acts 231 and 251.

49. "Former two-term Governor of Michigan, Jennifer Granholm, joins Proterra's Board." Proterra. (March 2017). Accessed October 26, 2017. https://www.proterra.com/press-release/former-two-term-governor-of-michigan-jennifer-granholm-joins-proterras-board/.

50. "Overview of Michigan's Advanced Battery Technology." Kettering University. (August 2009). Accessed October 26, 2017. https://news.kettering.edu/news/overview-michigans-advanced-battery-technology.

51. Id.

52. Colias, Mike. "GM to Add 2nd shift, 1200 jobs at Detroit-Hamtramck plant." Crain's Detroit Business. Oct. 22, 2015. http://www.crainsdetroit.com/article/20151022/NEWS/151029947/gm-to-add-2nd-shift-1200-jobs-at-detroit-hamtramck-plant.

53. "Taming the Autonomous Vehicle: A Primer for Cities." Bloomberg Philanthropies. (March 2017) p. 27. Accessed on October 26, 2017. https://www.bbhub.io/dotorg/sites/2/2017/05/TamingtheAutonomousVehicleSpreadsPDF.pdf.

54. Harder, Amy. "Why China is winning the clean energy race." AXIOS. October 13, 2017. https://www.axios.com/why-china-is-winning-the-clean-energy-race-2496091771.html. Accessed October 26, 2017.

55. MCL 257.665(6).

56. "The Electrification Roadmap." Electrification Coalition. (November 2009). Accessed October 26, 2017. http://www.electrificationcoalition.org/sites/default/files/SAF_1213_EC-Roadmap_v12_Online.pdf.

57. Smith, Dory. "KC metro leads the nation in EV adoption." Kansas City Business Journal. (July 2017). Accessed October 26, 2017. https://www.bizjournals.com/kansascity/news/2017/06/07/kc-metro-electric-vehicle-adoption.html?ana=RSS%26s=article_search.

58. "The Electrification Roadmap." Electrification Coalition. (November 2009). Accessed October 26, 2017. http://www.electrificationcoalition.org/sites/default/files/SAF_1213_EC-Roadmap_v12_Online.pdf.

59. Fitzgerald, Garrett and Chris Nelder. "From Gas to Grid." Rocky Mountain Institute. (2017). p. 27. Accessed October 26, 2017. https://www.rmi.org/wp-content/uploads/2017/10/RMI-From-Gas-To-Grid.pdf.

60. Fitzgerald, Garrett and Chris Nelder. "From Gas to Grid." Rocky Mountain Institute. (2017). p. 27-28. Accessed October 26, 2017. https://www.rmi.org/wp-content/uploads/2017/10/RMI-From-Gas-To-Grid.pdf.

POWERING
THE
MOBILITY
REVOLUTION