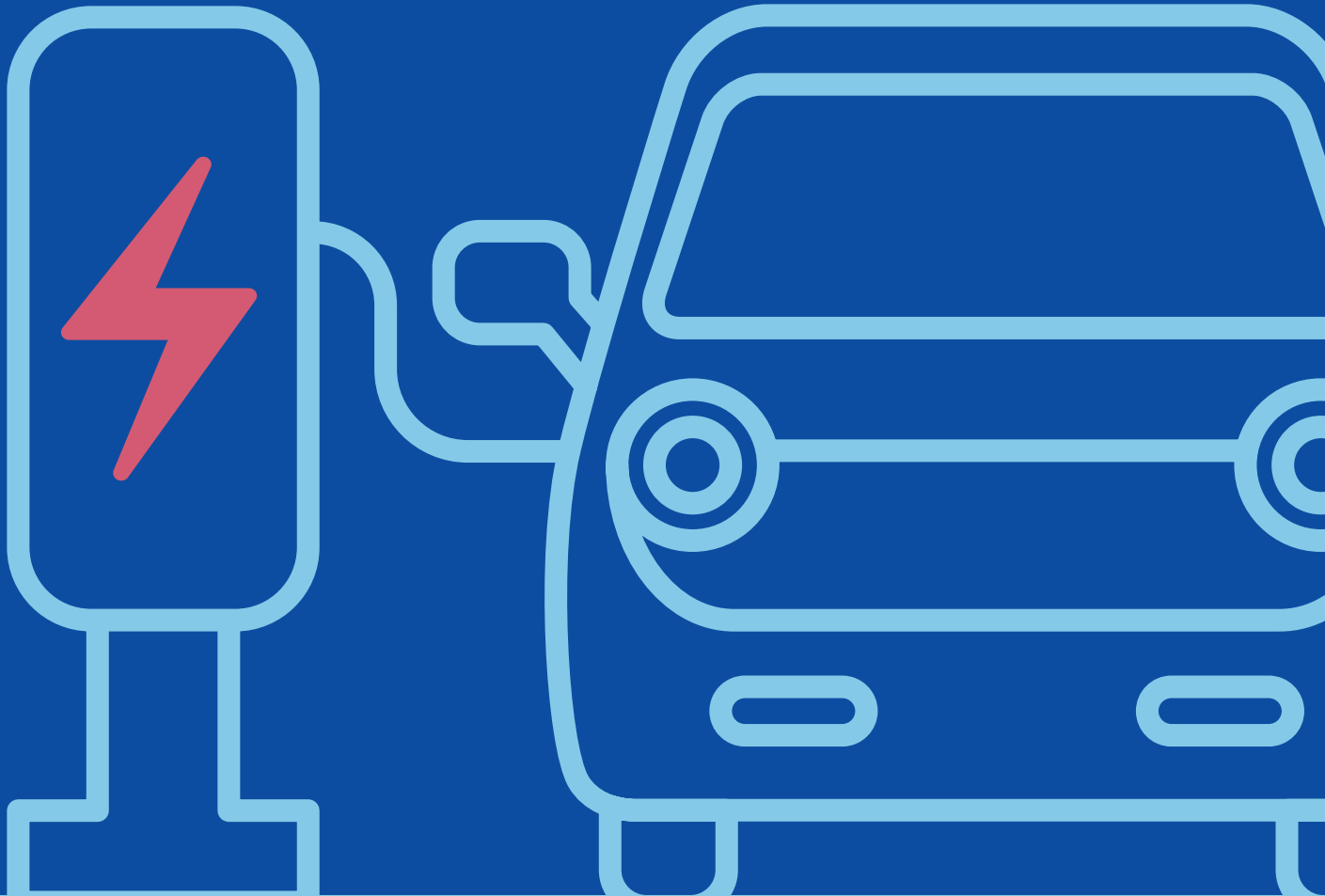


# THE ABCs OF OHIO



# EVS

A POLICY  
GUIDE TO  
ELECTRIFY  
OHIO



The Citizens Utility Board of Ohio (CUB Ohio) is a consumer advocate working on behalf of residential and small-business utility customers. We're a nonpartisan nonprofit with membership across the state, and we work for cheaper bills, reliable service, transparency, consumer rights, and clean, healthy energy. For more information, visit [www.cuboh.org](http://www.cuboh.org).

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# THE ABCs OF OHIO EVs

## A POLICY GUIDE TO ELECTRIFY OHIO

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# Electrification Is in Motion

**D**riven by market dynamics, consumer preferences, advances in technology and public policy, electrification of the global vehicle fleet is underway. With the transportation sector as today's largest source of carbon dioxide emissions causing climate change,<sup>1</sup> achieving the national objective of reducing carbon emissions to 50% of 2005 levels by 2030 will require a transition from fossil-fueled cars and trucks to Electric Vehicles (EVs<sup>2</sup>).

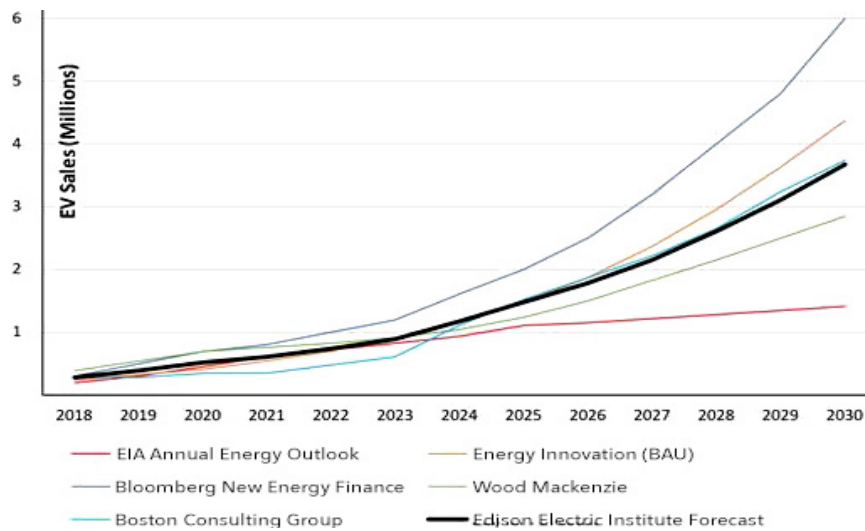
In 2020 EVs comprised just 2.4% of the 15 million light vehicles sold annually in the US, but that market share is expected to mushroom in coming years, reaching 3.5% in 2021, more than 10% by 2025, and a projected 67% by 2040.<sup>3</sup> Many other countries are

further down the EV path, with market penetration already hitting 15% in Europe and China.<sup>4</sup> EV sales in the US vary dramatically by region, with the EV share of the West Coast car market at 10%, while the Midwest lags with EV sales of less than 2%.<sup>5</sup> For EVs to reach President Biden's goal of half the auto market by 2030, sales must grow by 35% each year for a decade.<sup>6</sup>

At the beginning of 2021, Ohio ranked 17<sup>th</sup> among all states, with 14,530 registered EVs.<sup>7</sup> That number doubled to 28,595 by July 2021, rising to 1.72% of new car registrations.<sup>8</sup> However, as we begin the transition just one out of every 300 passenger vehicles on Ohio roads is powered by electricity.



1 <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>; 29% of US carbon dioxide emissions are from transportation, 25% electricity generation, 23% industrial, 13% commercial and residential, and 10% agriculture.  
2 As used herein, EV refers to a car or light truck that plugs in and can drive on electricity only, including Battery Electric Vehicles (BEV) and Plug-in Hybrid Vehicles (PHEV).  
3 See <https://www.bloomberg.com/news/articles/2021-08-09/at-least-two-thirds-of-global-car-sales-will-be-electric-by-2040>, <https://insideevs.com/news/489525/us-electric-car-market-share-record-2020/> and <https://www.businesswire.com/news/home/20210208005423/en/Canalys-Global-Electric-Vehicle-Sales-up-39-in-2020-as-Overall-Car-Market-Collapses>  
4 <https://www.acea.auto/fuel-pc/fuel-types-of-new-cars-battery-electric-7-5-hybrid-19-3-petrol-41-8-market-share-in-q2-2021/>, <https://www.greencarcongress.com/2020/09/20200904-acea.html>, <https://insideevs.com/news/522274/china-plugin-car-sales-june2021/> and <https://cleantechnica.com/2021/04/23/11-plugin-vehicle-share-in-china/>  
5 <https://insideevs.com/news/506502/california-plugin-car-sales-2021q1/>  
6 <https://www.whitehouse.gov/briefing-room/statements-releases/2021/08/05/fact-sheet-president-biden-announces-steps-to-drive-american-leadership-forward-on-clean-cars-and-trucks/>  
7 See national data at <https://afdc.energy.gov/data/>  
8 Current state data at <https://drive.ohio.gov/wps/portal/gov/driveohio/about-driveohio/resources/ohio-alt-fuel-vehicle-reg-dashboard>

Figure A: Annual Electric Vehicle Sales Forecast, U.S.<sup>1,2,3,4,5,6</sup>

Credit: DriveOhio/HNTB Electric Vehicle Charging Study, June 2020

1. U.S. Energy Information Administration (EIA) — Annual Energy Outlook 2018 Reference Case (February 2018): <https://www.eia.gov/outlooks/aeo/>
2. Bloomberg New Energy Finance (BNEF) — Electric Vehicle Outlook 2018 (May 2018): <https://about.bnef.com/electric-vehicle-outlook/#toc-download>
3. Boston Consulting Group (BCG) — The Electric Car Tipping Point (November 2017): <https://www.bcg.com/en-us/publications/2018/electric-car-tipping-point.aspx>
4. Energy Innovation — Energy Policy Simulator 1.4.1: <https://us.energypolicy.solutions/scenarios/home>
5. Wood Mackenzie — The Electric Vehicle Outlook Data (August 2018): <https://www.woodmac.com/nslp/electric-vehicles-guide/>
6. Edison Electric Institute and Institute for Electric Innovation. Plug-in Electric Vehicles Sales Forecast Through 2030 and the Charging Infrastructure Required. November 2018. <http://www.ehcar.net/library/rapport/rapport233.pdf>

Although global automobile sales fell 16% overall in 2020 due to the COVID-19 pandemic, EV sales rose 41% for the year and more than doubled in the first half of 2021.<sup>9</sup> Auto industry investments and announcements leave little doubt that the momentum will continue. For example, GM plans to produce 30 new electric models by 2025 and vows that its light duty vehicles will be 100% electric by 2035.<sup>10</sup> Stellantis (formerly Fiat-Chrysler) is introducing 10 new EVs in 2021 and Ford has announced it will invest \$29 billion in EV development over the next five years.<sup>11</sup> Meanwhile, EV industry leader Tesla targets annual sales growth of 50%.<sup>12</sup> With the impending introduction of a new generation of EVs with higher range and lower costs, a tipping point toward mass market adoption appears to be on the horizon. At the same time, however, two-thirds of American consumers have never been in an EV and nearly one-third say they never plan to buy one.<sup>13</sup>

Transportation Electrification (TE) can be a driver of cleaner air, reduced carbon emissions, lower transportation costs, enhanced grid reliability and a more efficient electricity system. But for EVs to evolve from a niche market to mass adoption in a way that captures

these benefits requires supportive and effective public policy at the federal, state and local levels.

Much of the jurisdiction over the electricity industry lies with our state legislature and utility regulators. Both the Ohio General Assembly and Public Utilities Commission of Ohio (PUCO) face critical questions surrounding TE planning, infrastructure, rules, rate design, and equity. The right TE policies and programs — reflecting Ohio’s market structure, supply mix, load dynamics, and social goals — **can ensure that everybody from Ashtabula to Cincinnati will benefit from EVs, whether or not they drive one.** But poorly designed or nonexistent policies will lead to higher costs and lower benefits, hampering the electrification trend and exacerbating economic and social divisions.

The right TE policies and programs ... can ensure that everybody from Ashtabula to Cincinnati will benefit from EVs, whether or not they drive one.

In this report, the Citizens Utility Board of Ohio examines key issues facing our state. We propose guidelines for policy development and specific measures to help propel this emerging market transformation and ensure its benefits reach all Buckeyes.

9 See <https://www.iea.org/reports/global-ev-outlook-2021> and <https://www.marketwatch.com/story/ev-sales-continue-to-gain-ground-11627581876>  
 10 <https://www.nbcnews.com/business/autos/gm-go-all-electric-2035-phase-out-gas-diesel-engines-n1256055>  
 11 <https://media.ford.com/content/dam/fordmedia/North%20America/US/2021/02/03/fin-4q20-ford.pdf>  
 12 <https://insideevs.com/news/482501/tesla-q4-2020-deliveries-2021-target/>  
 13 See JD Power survey results: <https://www.tdworld.com/distributed-energy-resources/article/21146109/survey-highlights-absence-of-consumer-interest-in-bevs-selfdriving-technologies>

### SUMMARY: THE TASK AHEAD

Why should Ohio policymakers and advocates concern themselves with EVs? After all, regulators don't typically focus on end-use electricity — there aren't proceedings about refrigerators or coffee-makers. EVs need special attention because they are different from other appliances in ways that have profound implications for the electricity system.

An EV in the garage could increase the electricity consumption of a typical household by 40% — and millions of them plugged in could require costly expansion of electricity delivery and generation capacity. But if EVs are managed as distributed energy resources, the rise of transportation electrification can lead to lower — not higher — electric rates for all consumers.

This Ohio CUB report is intended to help our state develop a strategy to capture the potential of explosive EV growth and use it to optimize our state's electric system. We identify factors affecting EV market growth, assess its ramifications for the electric grid and for consumers, advance principles to protect the interests of electricity customers, and recommend responsive state actions.

The decisions Ohio makes must be in sync with our state's social goals, geography, energy market structure, supply technologies, load dynamics, and

economic forces. Policymakers will need to consider threshold questions about the applicability of state regulatory authority to issues beyond the scope of traditional utility regulation. The lengthy list of topics for examination include:

- Equity and inclusion to bring EV benefits to all Ohioans.
- Consumer protection, education and information.
- Implications of EV growth for load shapes, electric rates and rate designs.
- Options for ensuring adequate charging infrastructure.
- Addressing geographic and demographic disparities in EV adoption.
- Fair allocation and recovery of EV-related costs and investments.
- Advanced metering, charging, and load management strategies to optimize system efficiency.
- Value, scale, design and funding of pilot programs.
- Opportunities for regional cooperation.
- Roles of public utilities, private vendors, local government, EV owners, and other stakeholders.

Consumer value, system optimization, equity and fairness should be the priorities shaping EV policy. This guide provides an overview of the nascent electrification of Ohio transportation and suggests a path toward achieving these goals.



# Part 1: It's Not Your Father's Automobile

**B**ecause anybody can bring home an EV and plug it in, an electric car may appear to be just like any other big electrical appliance. But EVs are different from rolling refrigerators because they store electricity and have controllable demand. With large intermittent loads and manageable charging schedules, EVs are an entirely new form of electrical device, with unprecedented potential for consumer and system benefits.

The physics of electricity — the need to keep supply and demand perfectly balanced at every moment for the power grid to function — and the limits of 20<sup>th</sup> century technology resulted in deployment of an inefficient electricity system. Generation, transmission and distribution had to be sized to serve uncontrolled peak electricity demands, leaving tremendous excess capacity most of the time. In recent decades the focus of attention turned to making the grid more efficient, through energy efficiency, demand management, and energy storage. Now the urgency of the global climate crisis has added reduced emissions to the list of objectives. The scale and flexibility of EV charging loads makes them key resources to help advance the goals of optimizing grid utilization and cost-effectiveness, while minimizing the environmental impact of transportation.

## **TE WILL SAVE EVERYBODY MONEY — IF WE DO IT RIGHT**

Instead of higher costs for generation and delivery capacity that would otherwise be required to serve burgeoning EV demand, consumers would see lower electricity bills if surplus capacity were the primary resource for EV charging. Analyses by the Rocky Mountain Institute show that if the entire US fleet of cars and light trucks were converted to electricity, overall power consumption would go up by about 25%, but could be largely accommodated without additional power plants or grid expansion if EVs were charged at optimal times.<sup>14</sup> Using EVs as grid-supportive demand response resources would further fill gaps in system load shape and support

Consumers would see lower electricity bills if surplus capacity were the primary resource for EV charging.

grid operation, reducing the cost per unit of energy delivered. As the amount of solar and wind power grows, syncing EV charging with renewables' variable output

would add another level of system optimization. No other electricity loads have this much potential value.

Yet high EV charging demand would pose significant challenges to an ill-prepared system. When 20% of the 4.5 million cars in Ohio are electric — which may happen within a decade — we could see a 10% increase in overall electricity consumption. The biggest challenge will be not just cleanly producing the additional energy, but in managing when and where EV charging occurs so that all electricity users benefit. Ohio must start now to prepare for that future.

## **EV VS. ICE — IT'S NO CONTEST**

Jump-started by Tesla more than a decade ago, EV adoption has mushroomed in part due to supportive public policy but mostly as a market phenomenon. EVs are popular with some drivers because they are healthier for the environment and cheaper to operate, but others are attracted by their performance characteristics, which are superior to comparable internal combustion engine (ICE) vehicles. An EV's immediate torque, quick acceleration, low maintenance, smoother ride and lower noise levels (not to mention lack of exhaust fumes) have moved 96% of EV owners to say they would buy one again for their next car.<sup>15</sup>

Charging at home instead of filling up at a gas station has proven to be a welcome consumer convenience — soon to be made even easier with the option of plug-free wireless charging<sup>16</sup> — and you fuel up without having to touch pump handles or be exposed to potential health risks.<sup>17</sup>

EVs cost far less to operate than ICE vehicles, a comparative advantage that will grow as battery and motor technology continues to improve, and EV charging is optimized to reduce electricity costs. For

<sup>14</sup> <https://rmi.org/insight/electric-vehicles-distributed-energy-resources/>

<sup>15</sup> <https://pluginamerica.org/wp-content/uploads/2021/02/2021-PIA-Survey-Report.pdf>

<sup>16</sup> Norway, where 10% of all cars on the road and 75% of new cars sold are electric, is testing wireless charging infrastructure for taxis while they are waiting for passengers: <https://www.fortum.com/media/2019/03/fortum-and-city-oslo-are-working-worlds-first-wireless-fast-charging-infrastructure-taxis>

<sup>17</sup> See <https://www.reuters.com/article/us-usa-health-filth/gas-pump-handles-top-study-of-filthy-surfaces-idUSTRE7900G820111025>

## BETTER BATTERIES WILL BE A BIG BOOST

Today's EVs are powered by lithium-ion batteries — much like a cellphone or laptop but strung together by the thousands in large battery packs. LI batteries use a liquid electrolyte that makes them heavy, susceptible to deterioration over time, and unstable under very high temperatures. Solid state EV batteries are being developed by several manufacturers. They can hold twice the energy, weigh half as much, last twice as long, and can be charged more quickly. And in addition to being inherently safer than lithium-ion batteries, solid state batteries are expected to be cheaper to manufacture. That would be a “game changer” for EVs and sounds too good to be true — but small-scale solid-state batteries are already used for applications such as heart pacemakers. Billions of dollars are going into R&D, and solid-state EV batteries are anticipated to be commercialized later this decade.<sup>1</sup>

1 <https://www.autoweek.com/news/technology/a36189339/solid-state-batteries/>

example, the 2021 Chevy Bolt has a 66 kilowatt-hour (kWh) battery with an Environmental Protection Agency (EPA) — estimated range of 259 miles, so it travels 3.92 miles per kWh.<sup>18</sup> At the average Ohio residential rate of 13.13 cents per kWh, it would cost \$8.67 to “fill the tank” with electricity, compared to \$25.90 for gasoline to drive a 30 miles per gallon (mpg) ICE car the same distance (at \$3.00 per gallon).<sup>19</sup> But the actual cost of electricity to charge an EV at home is even less because the published average cost per kWh includes fixed monthly fees for electric service. The incremental cost to power an EV in Ohio averages about 10 cents per kWh — equivalent to about 75 cents per gallon of gasoline — and the cost of fueling an EV can be cut further by electricity rates that provide a discount at off-peak times.<sup>20</sup>

Using the Ohio passenger-vehicle average of 14,278 miles driven per year, annual fuel costs would be

\$1,428 for the gasoline-powered car and \$364 for the EV — a difference of \$1,064.<sup>21</sup> That's enough to finance about \$6,000 of the additional cost to purchase the Bolt, which at \$36,000 (and no longer eligible for a federal tax credit) remains a relatively expensive car for its size.

According to a study by the National Renewable Energy Laboratory, driving an EV will save up to \$14,500 in fuel costs over 15 years.<sup>22</sup> For many drivers, EVs are already an economical choice.

Figure B: Annual Fuel Costs to Power an EV vs. 30 MPG ICEV at Varying Gasoline Prices (assume 12,000 miles/year)<sup>23</sup>



EVs also have non-fuel cost advantages over conventional cars. Electric motors can be expected to last much longer than combustion engines. And with few moving parts in the motor, simple transmissions, no belts, hoses, muffler, spark plugs or catalytic converter, and no oil changes or engine tune-ups, EV maintenance costs have been 40% lower than ICE vehicles.<sup>24</sup> For example, Chevy's recommended maintenance schedule for the Bolt EV includes only tire rotation

18 <https://www.chevrolet.com/electric/bolt-ev>

19 At incremental rate of 10 cents per kWh, the cost to drive a typical EV traveling 3.57 miles per kWh comes to under 3 cents per mile. An ICE vehicle getting 30 MPG and paying \$3 per gallon of gas costs 10 cents per mile.

20 See for example AEP rate calculator at <https://www.aepohio.com/company/about/rates/>

21 <https://www.thezebra.com/resources/driving/average-miles-driven-per-year/#average-miles-driven-per-year-by-state>

22 <https://www.nrel.gov/news/press/2020/research-determines-financial-benefit-from-driving-electric-vehicles.html>

23 Chart data assumes 1,000 miles/month for typical light-duty passenger vehicle travel and 3.6 miles per kWh, the average efficiency of today's EVs. For list of all EVs' fuel consumption see: <https://ecocostsavings.com/electric-car-kwh-per-mile-list/>

24 <https://www.osti.gov/biblio/1780970>

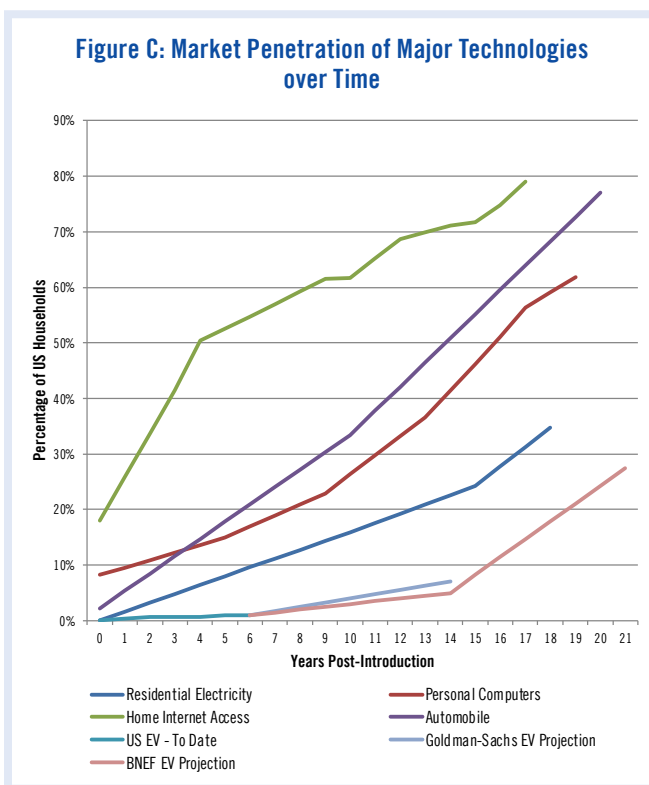


and new brake fluid every five years. One effect of low maintenance is that car dealers have been reluctant to push EV sales because servicing vehicles is a core part of their business model. That may change as EV models proliferate and competition grows.

While expensive to replace, EV batteries are required by law to be warranted for at least 100,000 miles and may have acceptable output far beyond that.<sup>25</sup> The batteries also have “second life” value for potential home use and grid support when no longer retaining enough capacity for powering a vehicle. The new Bipartisan Infrastructure and Jobs Act allocates \$3 billion toward expansion of facilities to recycle battery materials and another \$3 billion to advance battery materials processing technology.

### BARRIERS TO ELECTRIFICATION

Will EVs see explosive growth similar to personal computers beginning in 1984, the Internet in 1995, cellphones in 2000 or HDTV in 2005? All of these quickly became ubiquitous, supplanting earlier technologies seemingly overnight.



The car market will take longer to electrify, even as national policy begins to mandate decarbonization and support EV growth, because the average car lasts for 12 years — and 25% of cars stay on the road for more than 16 years.

One obstacle to mass adoption of EVs is uncertainty about gasoline prices, which means people can't forecast exactly how much they will save in operating costs by buying an EV. For some drivers the key barrier to going all-electric is “range anxiety.” That's the concern that an EV might run out of juice and strand drivers far from a charger or leave them waiting for hours while the battery charges. With the average car in Ohio traveling less than 40 miles a day and the typical all-battery EV (BEV) having a range of 250 miles (and growing), this concern is largely unfounded for local driving. However, the occasional long-distance highway trip makes it loom large in the minds of car buyers. They want bigger batteries and that means higher prices.

Range anxiety is fully eliminated by plug-in hybrid vehicles (PHEV), which operate on electricity for 20 to 50 miles, depending on battery capacity, before switching automatically to an auxiliary gas engine for longer trips. PHEVs are not zero-emission vehicles (ZEV) because they emit pollutants when operating on the gas engine, but they are important transitional vehicles on the road to a carbon-free future. As we will discuss further, convenient and fast-charging opportunities are essential to mass adoption of BEVs, but public support will be needed for sufficient charge station deployment.

### SHRINKING EV STICKER SHOCK

While the total life-cycle outlays to own and operate an EV have already dropped close to the average for similar ICE vehicles, EVs must have lower purchase prices for them to dominate the car market.<sup>26</sup> Federal tax credits of up to \$7,500 for the purchase of a new EV have been crucial in getting the EV market off the ground, but they are phased out for each car manufacturer as their EV sales pass 200,000 units.<sup>27</sup> And most of the rebates have gone to high-income households that can afford to buy an EV and have sufficient income to use the tax credit. Income-qualified EV incentives applicable to both new and

<sup>25</sup> <https://www.marketwatch.com/story/how-long-will-my-ev-battery-last-heres-what-to-know-11625774475#:~:text=For%20now%2C%20conservative%20estimates%20for,miles%20using%20the%20original%20battery>

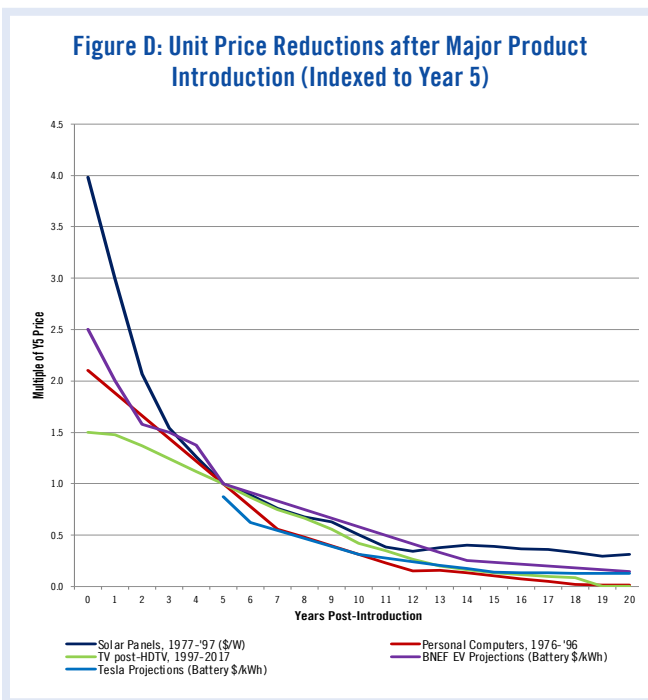
<sup>26</sup> <https://publications.anl.gov/anlpubs/2021/05/167399.pdf>

<sup>27</sup> Tesla and GM cars are no longer eligible under current law. Nissan may reach the threshold in early 2022 and Ford and Toyota not far behind. See <https://www.edmunds.com/fuel-economy/the-ins-and-outs-of-electric-vehicle-tax-credits.html>

used EV purchases would focus public subsidies where they are needed most.

Battery costs — which can make up one-third of the total cost of an EV — have fallen 90% in a decade, to an estimated average of \$137 per kWh of storage capacity, and they continue to drop by about 15% each year.<sup>28</sup> EVs will achieve price parity with ICE vehicles when battery costs fall to about \$100 per kWh, which may happen in several years.

**Figure D: Unit Price Reductions after Major Product Introduction (Indexed to Year 5)**



When they are price-competitive with conventional vehicles, EVs will be the preferred option for many car buyers, but another barrier to EV adoption will loom large: About one-third of homeowners and two-thirds of renters do not have a convenient place at home to plug in a car.<sup>29</sup> Many of these households are in multi-unit buildings in urban areas. A further challenge is that some homes don't have sufficient electric panel capacity to support high charging loads at the same time as other household usage.<sup>30</sup> These facts raise a range of emerging issues of EV equity that must be addressed by policymakers.

### COMING SOON: AUTONOMOUS VEHICLES (AVs)

“Self-driving cars” are not yet here, but remaining technological obstacles may soon be overcome, as a raft of leading tech companies are racing to solve them, including Apple, Intel, Tesla, Google, as well as various startups and many legacy car manufacturers. The social and political barriers to AVs are another matter, and it will take time before people are comfortable with the idea of driverless cars on the road. But when they arrive, the 100-year-old paradigm of car ownership may be upended, because when the car doesn't need a driver, many drivers will no longer need to own a car. Such a social shift seems far-fetched in a culture steeped in car ownership. However, “Mobility as a Service” may come to dominate urban transportation markets — and because of EV cost advantages, AVs will be electric.



28 See Bloomberg New Energy Finance survey <https://www.bloomberg.com/news/articles/2020-12-16/electric-cars-are-about-to-be-as-cheap-as-gas-powered-models>

29 See <https://www.census.gov/newsroom/press-releases/2020/2019-american-housing-survey.html> and as reported in a survey by the National Renewable Energy Laboratory: [http://www.afdc.energy.gov/uploads/publication/consumer\\_views\\_pev\\_benchmark.pdf](http://www.afdc.energy.gov/uploads/publication/consumer_views_pev_benchmark.pdf)

30 See <https://www.pecanstreet.org/2021/08/panel-size/>



## Part 2: Propelling the Policy Process

**E**V policies concern many stakeholders operating beyond the usual scope of state regulation. Important players on the EV field include not just utilities, consumer advocates, and regulatory commissions, but charge station providers, carmakers and dealers, transportation service companies, electricity generators, regional grid operators, charger technology companies, commercial property and charge site owners, community and civic groups,

*EV regulatory proceedings would benefit from a process to engage interested stakeholders at the outset – not in an adversarial docket but in a collaborative effort that develops a shared base of information and allows a free exchange of ideas and views.*

municipal governments, labor unions, and hardware, software and energy services providers. All of these stakeholders have something important to add to EV policy considerations. EV regulatory proceedings would benefit from a process to engage interested stakeholders at the outset – not in an

adversarial docket but in a collaborative effort that develops a shared base of information and allows a free exchange of ideas and views. In turn, the regulatory outcome would benefit from commonly understood policy priorities for EV integration, shared criteria for evaluating outcomes, and ultimately, a clearly stated set of goals for Ohio.

### **FIRST FACE THE FUNDAMENTALS**

EV policy consideration by public utility regulators raises threshold questions about regulatory scope, legal authority and policy framework including:

- **What is the statutory role of the Public Utilities Commission of Ohio (PUCO) in addressing transportation electrification?**  
*Improving reliability, affordability and quality of service is at the core of the state's regulatory responsibility. To what extent does EV policy fall under the Commission's general public interest mandate? What, if any, legislative changes may be appropriate?*

- **Does PUCO have authority to account for externalities such as the environmental effects of energy usage in setting regulatory policy?**  
*PUCO is not tasked with environmental regulation, though its oversight of utilities has significant environmental impact and sustainable energy has become a regulatory goal, reflected in Ohio’s renewable portfolio and energy efficiency standards, integrated resource planning, and now in initial EV support initiatives.*
- **Does PUCO have authority to target regulatory policy at a particular electricity end-use such as EVs? Is it the job of regulators to promote EV expansion? Should they tackle chicken/egg issues?**  
*“Build it and they will come” is not a traditional basis for regulatory policy, but utilities have always used growth projections for system planning. How should uncertain EV growth be projected in long-term utility planning?*
- **What is the right decisional framework for determining scope and scale of EV-supportive programs? What factors should be included in cost-benefit projections for infrastructure investment and new programs?**  
*The amount of spending and how it is recovered hinge on both the electric system effects and other key factors — such as whether to include social and environmental benefits beyond the traditional scope of Commission concern, how to quantify them, and appropriate time horizons.*
- **How should program or investment costs be allocated among customers and classes? Should existing costs be reallocated to support EV growth?**  
*Cost allocation is a zero-sum game in the short term, and cross subsidies are generally avoided. What approaches might be justified by the social benefits of TE?*
- **Does PUCO have authority (and would it be advisable) to put EVs on separate rates or demand response programs?**  
*Customer choice is generally preferable to regulatory mandates, but could incentives for participation by EV owners in programs to achieve regulatory goals include both “carrots and sticks?”*
- **To what extent are owner/operators of EV charge stations subject to regulation? Does the Commission have authority to create and enforce standards and consumer protections? Can funding or other public support be contingent on compliance with rules and codes of conduct?**  
*The growing EV charge industry asserts that EV charge stations are like cellphone chargers and are not a regulated provision of electricity. But state regulatory laws were not written with the system impact of EV charging in mind.*
- **Is the public charge market fully competitive or does it have elements of monopoly that might call for oversight and accountability?**  
*Competition among EV charge providers may not be sufficient to induce open access and interoperability, or to protect consumers from predatory pricing when they need a charge and have no other place to get it.*
- **What type of evidence is needed for regulators to make electrification policy decisions?**  
*At this early stage, EV policy is speculative but we need not wait for foreseeable problems to arise before addressing them. How can initiatives be “future-proofed” to avoid stranded costs?*
- **How might proposed policies and programs be tested through scalable pilot programs?**  
*Given the uncertainties about EV market evolution, demand for services, and utilization of infrastructure, pilots are needed to gauge the efficacy of different approaches.*
- **Are Ohio utilities different from one another in ways that might affect EV policies?**  
*Do different geo-demographic, EV adoption rate, and other service territory characteristics have policy implications? What metering technology is in place and planned? Would existing utility systems (software, billing, and hardware) need modification to accommodate preferred EV solutions, and at what costs and benefits to whom?*

# Part 3: Electrification Must Leave Nobody Out

**E**Vs are almost non-existent in low-income neighborhoods. Many households cannot afford any kind of car, or residents prefer to walk, bike or take public transportation. Those who own a car often lack a place where they can park and plug in. And although over time the operating savings can make the cost of an EV lower than a traditional car, the initial outlay for a new EV remains beyond the reach of consumers with limited incomes. Low-income buyers also face obstacles to financing, and vital EV information can be difficult to find for those whose native language is not English.

## CONFRONTING OBSTACLES TO EV OWNERSHIP

Combined with consumer education, innovative programs like the following would bring personal EVs to under-resourced communities:

- Income-based rebates for used EVs and home chargers. Some pre-owned EVs are available at lower prices than similar ICE vehicles, and their low operating costs make them a clean energy bargain — provided that convenient charging opportunities are available.
- Income-based swap programs to facilitate trading-in ICE vehicles for EVs or other clean energy mobility solutions.
- Geo-targeted public charge station development (possibly with discounts for local residents).
- EV-sharing programs in low and moderate-income neighborhoods. (Several cities have been experimenting with discounted EV sharing for low-income residents.<sup>31</sup> A small-scale shared-EV program has begun operating in Lorain County, Ohio.<sup>32</sup> And the City of Oberlin provides two EVs for residents to use at a cost of \$8/hour.<sup>33</sup>)
- Other clean and low-cost last-mile transportation initiatives, including e-scooters and e-bicycles, could be piloted in environmental justice communities.<sup>34</sup>

## AN OHIO EV ROADBLOCK

Ohio has become one of the 20 states to impose special costs on EVs intended to replace gasoline taxes that pay for road maintenance. Unfortunately our \$200 annual fee is among the nation's highest.<sup>1</sup> And it amounts to 30% more than an average ICE car would pay in annual state gasoline taxes.<sup>2</sup> These high fees penalize EV drivers and deter EV sales at a time when we should be encouraging them.

Higher efficiency vehicles — whether ICE or EV — will soon make gas taxes an outdated revenue source, which could be replaced by taxes based on vehicle miles traveled (VMT), a more fair and reliable funding source.<sup>3</sup> Several states, including Oregon and Utah, are already testing VMT taxes, and a voluntary national pilot of the concept is included in the new Bipartisan Infrastructure and Jobs Act. Ohio should join other states in seeking better ways to make up for shrinking gas tax revenue.

- 1 <https://www.ncsl.org/research/energy/new-fees-on-hybrid-and-electric-vehicles.aspx>
- 2 Ohio gas tax of 38.5 cents gallon. 30mpg car would use 400 gals to drive 12,000 miles, and pay \$154 in state tax
- 3 <https://taxfoundation.org/road-funding-vehicle-miles-traveled-tax/>

- Support for extension of electricity wires and plugs to parking areas of multi-unit buildings.
- On-street charger options, perhaps using existing grid-connected infrastructure such as streetlights.<sup>35</sup>

Private-sector efforts to make EVs more available are emerging as part of sustainability initiatives. For example, Columbus Yellow Cab (in conjunction with Clean Fuels Ohio and with support from the Department of Energy) is leveraging its growing EV fleet to bring EV Mobility Hubs to neighborhoods

31 <http://www.airquality.org/Our-Community-CarShare/Apply-for-Our-CarShare>; also <https://www.bluela.com/UPDATE?>

32 <https://energynews.us/2021/07/01/electric-car-share-program-helps-underserved-and-unemployed-ohioans/>

33 <https://www.swaymobility.com/oberlin-carshare>

34 See <https://www.nytimes.com/2021/03/02/travel/ebikes-bike-sharing-us.html> and <https://www.bikeshare.com/>

35 Kansas City has initiated a pilot program to install EV chargers on streetlight poles; see: <https://metroenergy.org/programs/current-projects/streetlight-ev-charging/#readmore>

around Columbus. Each of these mobility hubs will have several EVs and fast chargers for public use, accessible through an app-based platform.<sup>36</sup>

Efforts to bring personal EVs to all communities are key components of sound TE policy. But the core policy goal must be to make sure everybody benefits, whether or not they ever drive an EV.

**DIRTY AIR IS A SILENT KILLER**

The mortal threat of the COVID-19 pandemic may be receding but there is no vaccine to stop air pollution and unchecked climate change. Overburdened and underserved urban communities are disproportionately vulnerable to these threats, just as they have been to the pandemic, making environmental justice an urgent concern for the post-pandemic world.

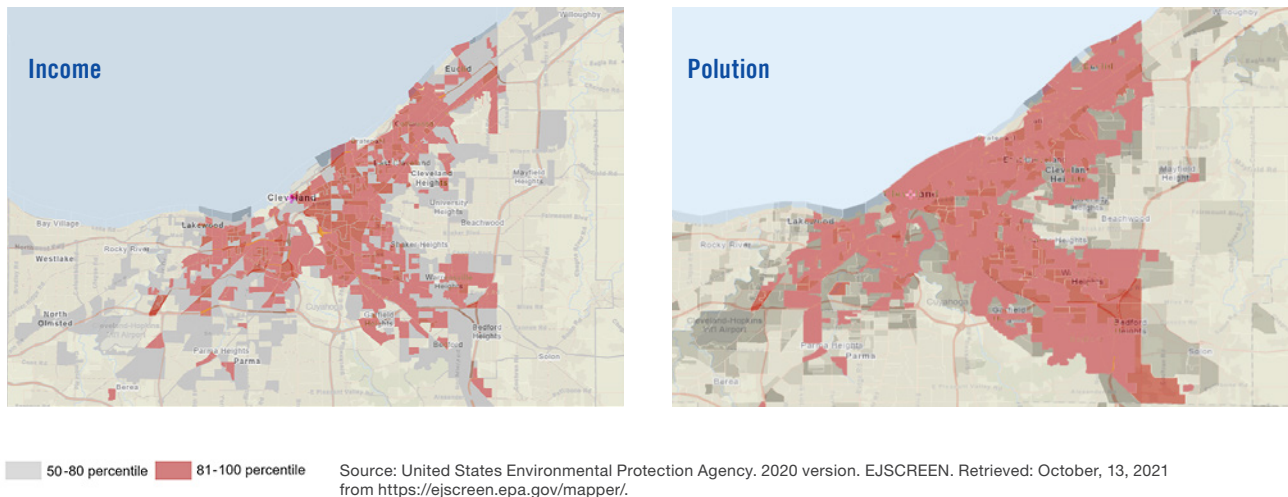
One hazard common to many lower- and moderate-income neighborhoods is chronic exposure to dangerous levels of toxic air. As coal plants have begun to close and electricity production has gradually become cleaner, the largest US source of pollution and carbon emissions is now the transportation sector. Petroleum fueled cars and trucks emit a noxious stew of chemicals and particulate matter.

**Ohio has the second-worst air quality of all states,** according to the Air Quality Index maintained by the Environmental Protection Agency (EPA).<sup>37</sup> More than 1.4 million Ohioans suffer from lung disease. Low-income neighborhoods are disproportionately harmed by air pollution because they are often located near multiple sources, including industrial facilities, highways, bus depots and truck corridors.

Diesel fueled buses and trucks are among the worst urban air polluters, producing 40 hazardous chemicals including hydrocarbons, smog-forming nitrogen-oxide (NOx), carbon monoxide, benzene and volatile organic compounds. Diesel fuels also produce high levels of small particulate matter (PM 2.5), a prime contributor to asthma and lung disease, which are prevalent in low-income urban communities.<sup>38</sup> Excessive exposure to PM 2.5 is also correlated with sub-optimal cognitive performance and learning disabilities.<sup>39</sup>

Cincinnati and Cleveland both are in the 15 US cities most polluted with particulates.<sup>40</sup> Intermodal freight terminals that produce high levels of these pollutants are often heavily concentrated in low-income Black and Latinx neighborhoods. According to the American Lung Association, Ohio would avoid \$2.4

**Figure E: Maps of Cleveland's low-income households and highest levels of PM 2.5 Pollution**



36 [https://www.energy.gov/sites/default/files/2021-06/ti123\\_stein\\_2021\\_o\\_5-14\\_634pm\\_KS\\_ML.pdf](https://www.energy.gov/sites/default/files/2021-06/ti123_stein_2021_o_5-14_634pm_KS_ML.pdf)  
37 <https://worldpopulationreview.com/state-rankings/air-quality-by-state>  
38 See EPA <https://www.epa.gov/pm-pollution/particulate-matter-pm-basics>  
39 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5499513/>  
40 <https://www.lung.org/research/sota/key-findings/year-round-particle-pollution>

## LIFE-CYCLE CARBON FOOTPRINTS: ICE VS EV

The environmental impact of a vehicle includes the emissions produced by mining and manufacturing all its components plus its operation for the 15-year period that an average car is on the road. While EVs themselves emit no pollutants or carbon dioxide, the emissions of an EV are determined by the source of its electricity, which varies from region to region and time to time. Even where coal remains the primary fuel for electricity generation, power to run EVs is generated more cleanly than by gasoline. This has been demonstrated in many studies, most recently by the International Council on Clean Transportation, which found that life-cycle EV emissions are 60-68% less than gas vehicles in the US, an advantage that is quickly growing as the electricity mix moves toward cleaner fuels.<sup>1</sup> Ohio's electricity is provided through the PJM Interconnection, which covers all or part of 13 states. The proportion of coal in the fuel mix has dropped from 32% to 21% in just three years and continues to decline as coal plants are retired.<sup>2</sup>

1 <https://theicct.org/publications/global-LCA-passenger-cars-jul2021>

2 <https://www.pjm.com/-/media/committees-groups/committees/mc/2021/20210329-special/20210329-state-of-the-market-report-for-pjm-2020.ashx>

billion in health costs during the year 2050 as well as 207 deaths, 2,860 asthma attacks and avoid 12,208 lost workdays — by electrifying transportation.<sup>41</sup>

### ENERGY BURDENS KEEP GROWING FOR THOSE WHO CAN LEAST AFFORD THEM

Air pollution and carbon emissions are invisible long-term perils but paying utility bills is an every-month challenge for lower- and moderate-income people, whose proportion of income going toward utility bills averages three times greater than households with higher income.<sup>42</sup> While disconnections for non-payment were voluntarily suspended by utilities for several months during the COVID-19 emergency, job losses caused arrearages to pile up for many customers, adding to future costs and potential disconnections. Ohio's four largest utilities — First Energy, American Electric Power (AEP), Duke, and Dayton Power & Light — disconnected more than 200,000 households during the peak of the pandemic, according to filings with the PUC.<sup>43</sup>

The national Low-Income Home Energy Assistance Program (LIHEAP) has been expanded by pandemic relief legislation but remains far short of meeting the need. About 350,000 households in Ohio are assisted

by LIHEAP, but more than 25% of Ohioans — 1.3 million families — have income levels that qualify them for participation under state guidelines.<sup>44</sup> Ohio also has a smaller Percent of Income Payment Plan (PIPP) that allows low-income people to maintain utility service and reduce arrearages by paying 6% of their income toward utility bills. Applications for these programs can be anticipated to increase as the hardships continue, but limited funding would mean smaller levels of support for each household. If present levels of LIHEAP and PIPP funding were spread over all eligible Ohio households, the average annual benefit would amount to about \$150 — not even enough to pay one month's typical electric and gas bills.<sup>45</sup> Reducing the energy burdens of low-income households must be a goal of electrification policies.

### TE MEANS CLEANER AIR AND LOWER CARBON EMISSIONS

Silver linings were difficult to find in the pandemic cloud, but throughout the country, smog lifted a bit and skies cleared — temporarily. In the Spring of 2020 emissions of pollutants in New York were less than half the typical amount, and in Southern California

41 State data at: <https://www.lung.org/getmedia/99cc945c-47f2-4ba9-ba59-14c311ca332a/electric-vehicle-report.pdf>

42 See Oak Ridge National Lab report: <https://info.ornl.gov/sites/publications/Files/Pub124723.pdf>

43 See reports filed in PUC proceedings: <http://dis.puc.state.oh.us/CaseRecord.aspx?Caseno=21-0548&link=DIVA> <http://dis.puc.state.oh.us/CaseRecord.aspx?Caseno=20-0937&link=DIVA>

44 175% of Federal Poverty Level is the standard. See <https://www.census.gov/quickfacts/fact/table/OH/PST045219>, and <https://development.ohio.gov/wps/portal/gov/development/individual/energy-assistance/1-home-energy-assistance-program>

45 See <https://neuac.org/wp-content/uploads/2021/02/Ohio-State-Sheet-2022.pdf> and <https://wallethub.com/edu/energy-costs-by-state/4833>

levels of particulate matter fell by 40% in April 2020.<sup>46</sup> Demand for gasoline and jet fuel plummeted, and the stay-at-home regimen provided a glimpse of how air quality would improve if millions of gasoline cars were replaced with pollution-free EVs.<sup>47</sup> The Southwest Ohio Air Quality Agency reported a 19% reduction in nitrogen oxides for the Cincinnati area. The Mid-Ohio Regional Planning Commission found that ozone and particulate levels were lower in the Columbus area. Unfortunately, as the economy opened up, pollution levels rose.<sup>48</sup>

A comprehensive cost-benefit analysis of the effects in Ohio of different EV penetration scenarios was conducted by MJ Bradley & Associates, an energy consulting firm.<sup>49</sup> It showed that in a high-penetration scenario, vehicle emissions would fall by more than 25% by 2030 — including the emissions from regional power plants used to generate the electricity for EV charging. The fuel mix is getting cleaner every year as coal plants close and wind and solar power grow. By 2050, overall emissions associated with vehicles would fall by 41% compared to 2015, according to the analysis.

### IT'S NOT ALL ABOUT CARS

Personal vehicles are only one piece of transportation electrification. Lower- and moderate-income communities will benefit from electrification of a range of transportation and mobility modes, including:

- **E-transit buses** — The pandemic highlighted the need for electrification of the nation's 80,000 intra-city public buses, but today less than 2% of the US fleet are zero-emission, including battery electric and hydrogen fuel cell.

While many office workers may be able to work from home, most lower- and moderate-income people have on-site jobs in service, industrial, and retail sectors. Public transportation is the only way for many people to access jobs that have been shown to be as essential to the economy as they are to individual livelihoods.

Electric transit buses require higher capital outlays and installation of charging infrastructure but have

## THE VALUE OF ELECTRIFICATION ISN'T FLEETING

Big private vehicle fleets are going electric. Amazon has ordered 100,000 electric delivery trucks, which not only is good for the brand but will save the company lots of money in the long run. That's because central fleet housing and smart charging will mean very low operating costs, and high utilization will allow quick recovery of the extra capital outlay. These economies apply to all fleets, the biggest of which are operated by governmental units. The State of Ohio operates fleets totaling 16,000 vehicles, many of which are ripe for electrification.

The US government owns 650,000 gas-powered vehicles, which President Biden has vowed to replace with EVs.<sup>1</sup> That appears to be a good long-term deal for taxpayers as well as the environment. A study found that 97% of the non-postal federal fleet vehicles could be replaced with EVs by 2030 at a net savings to the government.<sup>2</sup>

The 192,000 light duty vehicles of the Postal Service are especially suitable for electrification because they have predictable travel, are housed centrally and their charging can be fully managed. Unfortunately, the USPS presently intends to replace its fleet in coming years, but with 90% ICE vehicles, a decision that may take an act of Congress to change.<sup>3</sup>

- 1 <https://www.reuters.com/article/us-usa-biden-autos/biden-vows-to-replace-u-s-government-fleet-with-electric-vehiclesidUSKBN29U2LW>
- 2 <https://www.electrificationcoalition.org/federal-fleet-electrification/>
- 3 <https://chargedevs.com/newswire/us-house-advances-measure-to-provide-8-billion-funding-to-replace-usps-trucks-with-evs/>

many advantages over pollution-spewing diesel models.<sup>50</sup> In addition to being quieter, smoother and exhaust-free, e-buses provide:

- Estimated savings of \$458,000 per bus in fuel and maintenance costs over their lifetime.<sup>51</sup> These 40% savings could be monetized through

46 See <https://www.washingtonpost.com/weather/2020/04/09/air-quality-improving-coronavirus/> and [https://www.wsj.com/cdn.ampproject.org/vs/www.wsj.com/amp/articles/coronavirus-got-rid-of-smog-can-electric-cars-do-so-permanently-11586532988?usqp=mq331AQFKAGwASA%3D&amp\\_js\\_v=0.1#ampshare=https%3A%2F%2Fwww.wsj.com%2Farticles%2Fcoronavirus-got-rid-of-smog-can-electric-cars-do-so-permanently-11586532988](https://www.wsj.com/cdn.ampproject.org/vs/www.wsj.com/amp/articles/coronavirus-got-rid-of-smog-can-electric-cars-do-so-permanently-11586532988?usqp=mq331AQFKAGwASA%3D&amp_js_v=0.1#ampshare=https%3A%2F%2Fwww.wsj.com%2Farticles%2Fcoronavirus-got-rid-of-smog-can-electric-cars-do-so-permanently-11586532988)

47 See: <https://www.nasa.gov/feature/goddard/2020/nasa-model-reveals-how-much-covid-related-pollution-levels-deviated-from-the-norm>

48 See: <https://www.iqair.com/world-air-quality-report>

49 <https://mjbradley.com/sites/default/files/OH%20PEV%20CB%20Analysis%20FINAL.pdf>

50 For comprehensive overview of health benefits of transportation electrification see <https://www.lung.org/getmedia/99cc945c-47f2-4ba9-ba59-14c311ca332a/electric-vehicle-report.pdf>

51 [https://www.apta.com/wp-content/uploads/Public\\_Transit\\_Leading\\_In\\_Transition\\_To\\_Clean\\_Technology.pdf](https://www.apta.com/wp-content/uploads/Public_Transit_Leading_In_Transition_To_Clean_Technology.pdf)



financing mechanisms to defray today’s higher upfront costs.

- \$150,000 per bus in reduced annual healthcare costs due to avoided pollution, according to an analysis by Columbia University.<sup>52</sup>
- Zero tail-pipe emissions instead of the average of 117 metric tonnes per year for a typical diesel bus.

The Central Ohio Transit Authority in Columbus and Laketran, the public transit system in Lake County (east of Cleveland), have purchased their first battery-electric buses and intend to have them rolling by the end of 2021. Working with the Center for Transportation and the Environment, Ohio Sen. Sherrod Brown has proposed a plan to make the entire US bus fleet zero-emission by 2035.<sup>53</sup>

The initial rollout of e-buses should be targeted to environmental justice communities that are most in need of cleaner air. They can be configured to meet the new safety needs of passengers — for example, to have fresh rather than recirculated air flowing through the cabin.

- **Electric school buses** — America’s biggest transit system is its 485,000 school buses. Only a few hundred of them run on electricity, but the new federal infrastructure legislation allocates \$2.5 billion toward electrification of 20% of the US school bus fleet.<sup>54</sup> This is an urgent task, as new research shows that students who breathe diesel bus fumes on the way to and from school have lower scores on standardized academic tests.<sup>55</sup> Ohio EPA has allocated \$3 million of VW settlement funds toward an electric school bus pilot program.

The high initial costs of an e-bus — twice as much as an equivalent diesel bus (although that’s anticipated to come down with higher manufacturing volumes) — are offset over time by fuel cost savings, particularly if charged at low overnight rates.

School buses could get a charging boost in between their morning and afternoon shifts. And because school buses are often idle during the summer months of high air-conditioning demand, e-bus batteries could potentially provide grid support during peak periods.<sup>56</sup> The ability to have electricity flow both into and out of plugged-in vehicles — known as “V2G” (Vehicle-to-Grid) — turns school buses into potential sources of electricity when they are not on the road. Dominion Energy Virginia intends to put 1,000 V2G-capable e-school buses in service by 2025.<sup>57</sup> And the nation’s first V2G-capable school bus has been delivered in Illinois.<sup>58</sup>

- **E-trucks** — Truck exhaust causes enormous health problems, particularly in communities close to highways and truck depots, which are often predominantly lower- and moderate-income areas.<sup>59</sup> The U.S. has 9.3 million registered commercial trucks, including 2.9 million tractor-trailers (aka semi-trucks or 18-wheelers), which produce 8% of the nation’s total carbon emissions. With their enormous energy consumption and miles driven, trucks provide a huge opportunity for fuel cost savings. Like other fleet applications, they can benefit from economies of scale through central charging depots and can be smart-charged to further minimize costs.

Giant trucks need giant batteries and a network of fast charging stations on interstate highways, but truck manufacturers including Mack, Daimler, Chinese company BYD and several new entrants are investing in electric truck development and preparing to put the first models into service. With half the fuel and maintenance costs of diesel trucks, Tesla’s upcoming e-truck could pay for its extra initial cost in two years, the company claims.<sup>60</sup>

While access to adequate charging infrastructure on the road is a big challenge, many trucks are local day carriers that can be centrally charged using low-cost overnight power. A new freight industry study found that more than 5 million medium and heavy-duty trucks are suitable for electrification.<sup>61</sup>

52 <http://www.columbia.edu/~ja3041/Electric%20Bus%20Analysis%20for%20NYC%20Transit%20by%20J%20Aber%20Columbia%20University%20-%20May%202016.pdf>

53 <https://cte.tv/transition-us-fleet-report/>

54 <https://www.vox.com/future-perfect/2021/4/6/22364385/one-small-idea-in-bidens-infrastructure-plan-with-big-benefits-electric-school-buses>

55 <https://nationswell.com/diesel-school-bus-retrofits-improve-test-scores/>

56 See <https://electrek.co/2019/08/23/electric-v2g-school-bus-pilots-grow/>

57 <https://www.dominionenergy.com/our-stories/electric-school-buses>; also see <https://stnonline.com/partner-updates/a-guide-to-locating-funding-for-electric-school-bus-purchases/>

58 <https://insideeivs.com/news/497272/blue-bird-first-v2g-school-bus/>

59 <https://insideclimatenews.org/news/27102021/diesel-pollution-environmental-justice/>

60 <https://www.tesla.com/semi>

61 <https://www.canarymedia.com/articles/electric-vehicles/electric-trucks-could-handle-millions-of-short-haul-routes-across-north-america>

E-truck and commercial fleet charging depots could be located where the existing grid has sufficient capacity for their high loads, so investment in new distribution infrastructure can be minimized. These locations are often in areas where deindustrialization has occurred — exactly the places that need both non-polluting vehicles and new jobs.

**GETTING FROM HERE TO THERE**

A strategic plan at the outset is needed to bring transportation electrification to low-income areas. Planners should examine projected benefits, costs, and risks of options — mapped to those who will pay for it, and those who will derive value. Spreading the costs over the timeframes of their projected public benefits would be fair to utility customers and/or taxpayers, who would be supporting new programs.

Crafting a TE plan requires input and participation from stakeholders representing all perspectives, including low-income advocates, consumer, business, environmental, and community groups, utilities, and government agencies. Such an effort entails collaboration between groups that may have little

Crafting a TE plan requires input and participation from stakeholders representing all perspectives, including low-income advocates, consumer, business, environmental, and community groups, utilities, and government agencies.

experience working with each other, as well as internal communication and coordination within public and private institutions. The “silos” within large organizations often hinder effective action and must be bridged by leadership to create common purpose.

Input from low-income communities is indispensable. Communications planning starts with hearing from affected communities about policies that would address their needs and concerns.

Utility-implemented programs can be judged by their performance, including how well they achieve public goals. Metrics can be designed to measure progress in:

- Increasing availability and usage of electrified transportation in low-income areas.
- Improving efficient utilization of the electric grid.
- Lowering peak demand, improving load shapes.
- Improving affordability of electric service.
- Using EVs to integrate renewable and clean energy resources.
- Creating jobs in targeted areas.
- Cleaning air in high-pollution neighborhoods.
- Reducing carbon emissions.
- Putting downward pressure on electricity rates.

Progress and outcomes should be publicly and regularly reported. Plans should be evaluated and updated as conditions and public needs evolve. Any Electric Vehicle Service Providers (EVSP) receiving public or utility funding as part of a TE plan should be subject to reasonable standards and consumer protections.



# Part 4: Charging Ahead

**T**he environmental benefits of electrification are clear, and those who suffer the most from pollution have the most to gain. What is less widely understood is that **TE can also keep down the cost of electricity for all customers — even for those who don't own an EV.** But that won't happen automatically.

A 20% penetration of the car market — 50 million EVs on American roads — could mean new complications and costs for system operation. If the delivery system were to need added capacity to handle EV charging, all those additional wires, poles, transformers and equipment could lead to rate hikes for all electricity customers. And higher peak demand would raise market energy prices. On the other hand, if EV charging could be accomplished without significantly expanding electric system capacity, there would be downward pressure on electricity rates because the costs of the system would be spread over more kilowatt-hours (kWh) of energy sales. As we will detail, this positive outcome is achievable through regulatory policies that optimize EV charging patterns.

The MJ Bradley analysis (referenced earlier) projects the amounts by which EV charging revenue in Ohio might exceed new utility costs under different scenarios. It found that when EVs reach 25% of cars on the road — 2.3 million EVs in Ohio — utility revenues could increase by \$1 billion, with costs growing by a far smaller amount. If charging were managed to minimize the need for expanded capacity, Bradley projects the net present value to all utility customers would total \$127 million in 2030 under this high-penetration scenario. Each EV would increase utility net revenue by about \$450 over 10 years, most of which flows to utility customers through the regulatory process. However, without managed charging, this benefit largely disappears.

The stakes are enormous for Ohio's electricity consumers. A typical BEV in Ohio would consume almost 4,000 kilowatt-hours (kWh) each year, adding 34% to the 10,485kWh of annual electricity

consumption of an average Buckeye household (assuming 90% of charging is done at home).<sup>62</sup>

## DIFFERENT WAYS TO FILL 'ER UP

A typical EV uses about 30 kWh to travel 100 miles. To get that amount of electricity out of a 110-120 volt regular house wall socket (a Level 1 charge) takes 15 to 25 hours. Quicker home charges require installation of “Electric Vehicle Supply Equipment” (EVSE). Level 2 EVSE uses a 208-240 volt circuit (like an electric oven or clothes drier) and cuts charging time by 70-90%, depending on the capacity of the circuit and charger. To charge up a fully depleted battery with a

## WORKPLACE SLOW CHARGE: FAST ENOUGH?

80% of EV charging occurs at home but 15% is at work and that percentage may grow as more states, cities and employers decide to support workplace charging. According to the Department of Energy, an employee with access to charging at work is six times more likely to buy an EV.<sup>1</sup> And the effect is magnified when coworkers see EVs charging in the parking lot.

Huntington Bancshares is one of several big Ohio employers that have begun providing charge opportunities for employees — with 39 level 2 charge ports already installed at its Columbus facilities.

The average daily round-trip commute of 30 miles could be fueled by plugging into a standard 110-volt wall socket during the workday. Unless employees move their cars around to share limited numbers of level 2 chargers, it makes sense to accommodate large numbers of EVs cost-effectively by just installing standard electric sockets in parking spaces. Daytime workplace charging could be paired with solar panels and/or energy storage to avoid grid congestion.

1 [https://www.energy.gov/sites/prod/files/2017/01/f34/WPCC\\_2016%20Annual%20Progress%20Report.pdf](https://www.energy.gov/sites/prod/files/2017/01/f34/WPCC_2016%20Annual%20Progress%20Report.pdf)

62 Energy Information Administration data at <https://www.eia.gov/electricity/state/Ohio/>

250-mile range takes 8 to 12 hours on a typical Level 2 charge and more than 50 hours using a standard home wall socket.<sup>63</sup> Of course, an EV battery would never be fully depleted so actual charge sessions would take less time. Because longer distance local driving days are rare, most drivers don't need a level 2 charger at home and can charge their EV sufficiently at Level 1 by keeping it plugged in to a standard wall socket when parked.

Level 2 chargers are appearing at parking garages, retail stores, motels, shopping malls and other public locations. These chargers aren't fast or convenient enough to be most drivers' only energy source. But they are an easy way to "top-off" the battery while out and about — if you can find an available charger when you pull in.

For long highway trips and for those without a place to plug in at home, the next step up in charging speed is the DC Fast Charger (DCFC), also known as Level 3. Converting alternating current into direct current at 440-480 volts or above, the DCFC bypasses the onboard charger in the vehicle and feeds current directly into the battery through a separate connector (which often does not come as standard equipment).

Many fast chargers today operate at 50 kilowatts (kW), which adds 100 miles of range in about 30 minutes. Increasing the power to 150 kW can provide 100 miles in 10 minutes, and a 350 kW charger can provide 300 miles of range in as little as 15 minutes. However, existing stations are not yet capable of the highest charging speeds and few EVs today can accept them. Tesla has its own proprietary fast-charge network and says it will eventually be able to deliver a full charge in five to ten minutes (though its current vehicles could not accommodate this). Other car manufacturers are also building fast charging networks or partnering with third-party charge station developers. Volkswagen's "Electrify America" stations — being deployed as partial penance for the company's diesel cheating scandal — is open to all makes, and in Europe several car manufacturers jointly own "Ionity," a fast-charging network.<sup>64</sup>

### SHOULD EV ACQUISITION BE SUBSIDIZED?

Many states provide incentives to support EV acquisition and several provide purchase rebates in addition to the federal tax credit.<sup>1</sup> Market data suggest that each \$1,000 of state incentives corresponds to a 2.6% increase in EV sales. The most effective way to boost EV sales at the dealership may be through instant incentives. Instead of a rebate provided many months later through a tax rebate (which some customers can't even use because their tax bill isn't high enough), an immediate point-of-sale discount reduces the initial purchase price and therefore means lower monthly financing charges, a key measure of vehicle affordability. But are car purchase subsidies the best use of limited public funding to support EV growth? Should recipients be income qualified? Should such subsidies only apply to lower priced EVs? Should they be allowed for a household with multiple vehicles? What about used EVs, which are what most people can afford? Purchase incentives raise a raft of thorny issues of efficacy and equity.

1 <https://www.ncsl.org/research/energy/state-electric-vehicle-incentives-state-chart.aspx>

### OHIO BEGINS EV CHARGING SUPPORT

Across the country, the chicken/egg problem of chargers and EVs is being tackled in different ways. Approximately 45,000 public chargers have been installed in the US, although only 5,000 locations have DCFC and half of those only charge Teslas.<sup>65</sup> The new Bipartisan Infrastructure and Jobs Act puts \$7.7 billion into expansion of the public charge network toward the 500,000 ports that are projected to be needed to achieve electrification of half of new cars by 2030.<sup>66</sup> Charge station development will be supported through grant and incentive programs for state and local governments to leverage private investment. About \$140 million will be allocated toward EV charging infrastructure in Ohio.<sup>67</sup>

At last count Ohio had 793 public charge stations with 1,393 Level 2 and 332 Level 3 ports.<sup>68</sup> The Northeast Ohio Areawide Coordinating Agency is rolling out a

63 Note: The charger itself is actually in the car, not on the wall. The EVSE just delivers electricity to the charger, which converts AC to DC and sends current to the battery. Charging slows down when the battery gets to 80% capacity, to protect it from overheating.

64 <https://ionity.eu/>

65 [https://afdc.energy.gov/stations/#/analyze?country=US&fuel=ELEC&ev\\_levels=dc\\_fast](https://afdc.energy.gov/stations/#/analyze?country=US&fuel=ELEC&ev_levels=dc_fast) and [fhwa.dot.gov/environment/alternative\\_fuel\\_corridors/resources/ev\\_funding\\_report\\_2021.pdf](https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/resources/ev_funding_report_2021.pdf)

66 <https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-biden-administration-advances-electric-vehicle-charging-infrastructure/>

67 [https://www.fhwa.dot.gov/environment/alternative\\_fuel\\_corridors/resources/ev\\_funding\\_report\\_2021.pdf](https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/resources/ev_funding_report_2021.pdf)

68 <https://afdc.energy.gov/stations/states>

\$3 million federally funded charger program at public parking facilities, and the national settlement with Volkswagen over its diesel cheating scandal includes \$11.25 million for chargers in Ohio. However, the high expense of EVSE fast-charge infrastructure suggests that public and/or utility support will be necessary to bring it to sufficient scale.

The Public Utilities Commission of Ohio (PUCO) has approved two pilot programs to test ways to support EV charging, and others are under consideration. The first was authorized in 2018 for AEP, which is spending \$10 million on rebates — funded by utility customers — for 375 commercial charge stations in its Columbus Southern and Ohio Power service territories. In 2021 Dayton Power & Light/AES Ohio was approved to spend \$5.1 million on a similar rebate program. Funding is split 70/30 between Level 2 and Level 3 chargers,

with portions set aside for workplaces, multi-unit buildings, and public transportation providers.<sup>69</sup>

The Ohio Department of Transportation issued a report in 2020 that included mapping of 33 fast-charge station locations to adequately cover interstate highways with charging available at least every 50 miles.<sup>70</sup> Highway fast charge stations will need to accommodate periodic high demand, such as during a holiday weekend, and as EVs proliferate, the need for numerous charging ports at such locations will grow.

Imagine a fast-charge station with 20 cars plugged in simultaneously. The combined load could be 3,000 kW (3 MW), or enough juice to supply the average demand of 1,500 homes. Put several of those at an interchange and it's the equivalent of adding the peak load of a sizeable industrial facility. To serve passenger vehicle needs, highway charging stations would need far more capacity than would be used on an average day in order to serve peak periods, such as holiday weekends. The charging demands of big e-trucks would be even larger. But the fact that truck and car demand would peak at different times suggests that the charging needs of trucks and cars might be complementary. Adding electricity storage capacity at charge stations would be a way to moderate peak demand.

## SUPERFAST CHARGING WON'T BE CHEAP

The technology to fill a battery with electricity almost as quickly as a gas pump can fill the tank is feasible, especially when next-generation solid-state batteries arrive. But extra-high voltage/high amperage DCFC will be expensive to install, operate, and maintain, as it requires heavy-duty power infrastructure, high power delivery capacity and special cooling of delivery cables. If these costs were reflected in the charging fees paid by drivers, public fast charging would be an expensive alternative to charging at home, and few people would want to use it as their primary source of EV power. The “gas station” model is unlikely to become the primary mode for EV charging, not only due to its high costs but because system efficiency requires that most charging occur at off-peak times, such as overnight—but EVs on the road will charge during peak driving periods. Providing accessible and affordable public fast-charging for those who cannot plug in at home is a daunting challenge. One idea is to have “swappable” batteries, so a depleted one could be quickly replaced by a full one, much like a propane tank for a barbecue grill. Many companies are working on the technology and logistics, which may be particularly suited for fleet applications.

## NEW RATE STRUCTURES SHOULD BE ON THE TABLE

The high draw of DCFC chargers affects how much the operators pay for the energy they deliver to vehicles. A large part of commercial electricity costs is usually based on “demand charges” — fees based on the maximum amount of energy used at any moment during a month. If a fast charge station receives utility service under a demand rate, its intermittent use means very high average costs per unit of energy provided. Ohio’s policymakers need to consider whether a special set of utility tariffs is appropriate for charging stations. Demand charges could be reduced, perhaps temporarily, in order to encourage charge station development and reduce prices paid by drivers. At the same time, policies should encourage effective charge management to reduce costs and manage stress to the grid.

<sup>69</sup> Further details at <https://cleanfuelsohio.org/puco-ev-program-approval-positive-sign-for-future-program/#>

<sup>70</sup> See Drive Ohio EV Charger Siting Report at: [https://drive.ohio.gov/wps/wcm/connect/gov/4a58a392-917f-4735-8438-bfdbb3f0b7bd/2020-06-26\\_EV\\_Charging\\_Study.pdf?MOD=AJPERES&CONVERT\\_TO=url&CACHEID=ROOTWORKSPACE.Z18\\_M1HGIGIK0N0J000Q9DDDDM3000-4a58a392-917f-4735-8438-bfdbb3f0b7bd-nc08aJ2](https://drive.ohio.gov/wps/wcm/connect/gov/4a58a392-917f-4735-8438-bfdbb3f0b7bd/2020-06-26_EV_Charging_Study.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_M1HGIGIK0N0J000Q9DDDDM3000-4a58a392-917f-4735-8438-bfdbb3f0b7bd-nc08aJ2)



Advantageous rates could be contingent on the charge provider accepting rules designed to promote system efficiencies (such as incorporating energy storage) and to protect consumers.

For now, drivers who can't plug in at home will find charging an EV to take far longer than filling up at a gas station, and the higher price of energy from a public charger may reduce or eliminate the fuel cost savings. That's why innovative approaches should be tested, such as curb-side chargers and other ways to fit EV charging into different housing and parking settings.<sup>71</sup> For multi-unit buildings a cost-effective program to accommodate large numbers of EVs would be simply to install standard 110-volt wall sockets next to each parking space instead of a small number of more costly Level 2 chargers.

### **WHO SHOULD FUND, OWN, AND OPERATE PUBLIC CHARGE STATIONS?**

Many states are grappling with the question of what is the optimal role for utility companies in building out or supporting public EV charge stations. As owners and operators of the grid, there is no doubt that utilities have key functions. Policymakers must consider whether the advantages of having utilities build out public charging infrastructure outweigh concerns that

utility-owned charging facilities would shut out competitors and stifle innovation.

In addition to being service and price-regulated and accountable to regulators, utilities generally have access to low-cost capital, ability to integrate EVs as distributed energy resources (DER), call center capability, established customer relationships, and other incumbent and legacy advantages. However, construction and operation of EV facilities may not be within the core competency of utilities and they may lack the incentives and entrepreneurial culture of unregulated firms. Costs and risks of utility investment are borne by ratepayers, who are at risk of absorbing stranded costs in the event of underperforming or obsolete facilities. Fundamental questions arise: Do public charging networks — particularly DCFC — have “natural monopoly” characteristics? Is there a need for charge station accountability through the regulatory process?

Most states are concluding that utilities should provide only the electricity infrastructure for public charge stations, and private businesses should be the owners and operators. Whoever owns and operates charge stations, public (or utility) investment in them is premised on a set of implicit conditions:

<sup>71</sup> An MIT study revealed how different combinations of charging availability and supplemental vehicles enables EV proliferation; see: [https://www.nature.com/articles/s41560-020-00752-y.epdf?sharing\\_token=TtF-ibYnOHEfp0dl1HVp\\_9RgN0jAjWel9jnR3ZoTv0MuAf-m1jxfRYH9GRjVOtnA474s\\_uDKVM11hzXypPm2zu1J78RncNkTadFYduTPUSF844q-KjQ\\_PFSJbqbu6-lhQhMjZIU MXNbkoHFtHDzbtUcx7q7juHIGZW\\_xWXpMUo%3D](https://www.nature.com/articles/s41560-020-00752-y.epdf?sharing_token=TtF-ibYnOHEfp0dl1HVp_9RgN0jAjWel9jnR3ZoTv0MuAf-m1jxfRYH9GRjVOtnA474s_uDKVM11hzXypPm2zu1J78RncNkTadFYduTPUSF844q-KjQ_PFSJbqbu6-lhQhMjZIU MXNbkoHFtHDzbtUcx7q7juHIGZW_xWXpMUo%3D)

- Without public funding not enough charge stations will be built — or at least not soon enough and not in optimal locations.
- Utilization of charge stations will be sufficient to justify their deployment.
- Any net ratepayer or taxpayer costs will be exceeded by system and social benefits.

Because of widely differing circumstances and conditions, regulators across the country are coming to different conclusions about these assertions and what they mean for regulatory policy. Whatever the source or scale of public support for charge station development, policymakers must carefully examine the use cases of different charge options, how drivers will experience them, and what bang for the buck the public will get for investments of tax and/or ratepayer dollars.

### **INFRASTRUCTURE INVESTMENT INTRODUCES IMPORTANT ISSUES**

Involvement of public utilities in charge station development raises issues beyond competitive market effects, including risk and cost-sharing between site owners and utility customers, criteria for siting decisions and how they are made, what (if any) technology requirements are specified, physical and cybersecurity, amounts and uses of subsidies, as well as terms, conditions and operating rules (and how to enforce them).

Utility-owned charge stations would be under the purview of state regulators, which can approve tariffs and enforce consumer protection rules. However, independent third parties may be subject to far less, if any, regulatory oversight. This raises issues of service quality and consumer protection. In an effectively competitive public charging market, competition would constrain prices and protect consumers, but the very fact that subsidies would be needed shows that a robust market does not exist. When shopping for gasoline, there are usually multiple choices of where to fill up, but when drivers with a low battery pull up to a remote public charge station, they may be facing a situational monopoly, with no choice but to pay whatever it costs — or worse yet, to be unable to charge because the station is available only to certain vehicles or charge network members.

If utility funding or construction of charging infrastructure is found appropriate, adding the costs to ratebase would be one option to pay for it. Treating these investments as capital expenditures much like wires, poles, and other equipment allows longer term amortization, and a return on investment provides incentive for the utility. Alternatively, utility spending on charging infrastructure or other support could be recovered as operating expenses, or a combination of methods could be used for different types of utility funding and support.

In the initial stage of the industry, charge providers have introduced a number of business models, including closed networks and monthly fee requirements, which may not be appropriate for publicly subsidized facilities. Regulators should consider whether any subsidies be contingent on interoperability, model rate structures and constraints on terms and conditions. If Electric Vehicle Service Providers (EVSP) receive public or utility funding or other support, they should be subject to reasonable standards, reporting requirements and consumer protections.

### **INTEROPERABILITY IS ESSENTIAL**

Level 2 charge connectors are generally standardized, but for Level 3 fast charging, competing EV manufacturers utilize three different DCFC connectors.<sup>72</sup> Each claims to have technological and consumer advantages over the others, but what's essential for consumers is to be able to get a fast charge when and where they need it. Eventually, one standard may come to dominate the market, as we've seen with other new technologies such as video cassettes more than 30 years ago. However, such a sorting out process could take many years, posing an obstacle to EV growth if not addressed through collaboration between Tesla and other vehicle manufacturers.

Another barrier lies in the multiple networks for customer charging transactions. The pricing methods and costs of charging differ widely, not just due to electricity price variations and rate structures, but because some states prohibit volumetric rates for non-utility charge providers and allow fees to be assessed only by length of charging session. In Ohio, public charging fees are either per-minute or per-kWh. Some chargers require paid membership in a network

<sup>72</sup> CHAdeMO connector (an odd abbreviation for "CHArge de Move") is used by most Japanese manufacturers, though it is expected to be phased out in coming years. CCS (Combined Connector Standard) is used by most American and European companies, and Type 2 is used by Tesla (note: Teslas can be adapted to use non-Tesla stations, but other makes cannot presently connect to Tesla superchargers)



and may charge extra fees to non-members. It's a buyer-beware public charging market, with consumer fees varying from less than 10 cents per kWh (or even free for some level 2 chargers) to more than \$1 per kWh.

Making it easy for a driver to charge at any station anywhere in the country and to understand what it will cost are challenges to the EV charging industry.

Public policy should support interoperability — where a driver can easily plug into any charger and get service from any provider, much like they can use their cellphone on any network. The new federal infrastructure law allows federal funding only for chargers with open access payment methods that are available to all members of the public. PUCO as well as regulatory and advocacy organizations, such as the National Association of Regulatory Utility Commissioners (NARUC) and the National Association of State Consumer Advocates (NASUCA), can play roles in

**Public policy should support interoperability — where a driver can easily plug into any charger and get service from any provider, much like they can use their cellphone on any network.**

pushing the industry toward universal interoperability and full pricing disclosure.

### **REGIONAL AND NATIONAL APPROACHES MAKE SENSE**

Complicating the issues surrounding subsidies by utility customers of investment in charge stations is the fact that highway fast chargers would serve many non-local travelers who are just passing through a service territory. A multi-state approach may be an effective way to share the costs and benefits of highway fast charge infrastructure and to provide a seamless network and uniform customer experience. Such a regional effort has been initiated by eight Rocky Mountain states, which are coordinating on charger locations, operating standards, payment options and other policies.<sup>73</sup> Five Midwest states have begun an effort to coordinate charge networks, but Ohio has not yet joined this effort.<sup>74</sup> Large Ohio utilities, including Duke, First Energy and AEP have joined the Electric Highway Coalition, a group of 14 companies committed to working together to advance charging opportunities in their service territories.<sup>75</sup>

73 Nevada, Utah, Idaho, Montana, New Mexico, Arizona, Colorado, Wyoming; see <https://www.naseo.org/issues/transportation/rev-west>  
74 [https://www.npr.org/2021/10/01/1041987104/midwest-electric-vehicles-charging-evs-cars?utm\\_source=Energy+News+Network+daily+email+digests&utm\\_campaign=62e5c87d33-EMAIL\\_CAMPAIGN\\_2020\\_05\\_11\\_11\\_36\\_COPY\\_01&utm\\_medium=email&utm\\_term=0\\_724b1f01f5-62e5c87d33-89224039](https://www.npr.org/2021/10/01/1041987104/midwest-electric-vehicles-charging-evs-cars?utm_source=Energy+News+Network+daily+email+digests&utm_campaign=62e5c87d33-EMAIL_CAMPAIGN_2020_05_11_11_36_COPY_01&utm_medium=email&utm_term=0_724b1f01f5-62e5c87d33-89224039)  
75 <https://dailyenergyinsider.com/featured/31274-electric-highway-coalition-doubles-membership-in-fast-charging-station-rollout-effort/>



# Part 5: System Benefits Require Smarts

While EVs pose no immediate threat to reliability — most Level 1 home chargers draw less current than a hair dryer, or about 12 amps — high EV penetrations could pose problems if many drivers charge simultaneously, especially at high Level 2 current flows, which can reach 60 amps or more. Imagine a hot day in an EV-intensive neighborhood, where households are turning up their air conditioners and many drivers arrive home from work to plug in all at the same time. It's a typical scenario that could overload the distribution circuit, and perhaps the local substation. Meanwhile, at off-peak times and during periods of high local solar

Smart rate design and smart charging are key to avoiding the potential problems posed by big EV loads and maximizing their system benefit.

and/or wind generation output, the electric system has extensive underutilized capacity that could be used to charge EVs at little incremental cost. Smart rate design and smart charging are key to avoiding the

potential problems posed by big EV loads and maximizing their system benefit.

## REWORKED RATE DESIGNS ARE REQUIRED

Electric rate structure has a substantial impact on how much power is consumed and when that consumption occurs. Raising the cost of a kWh will cause people to use less of it. Raising prices at certain times and lowering them at other times will move some usage from the higher-priced to the lower-priced periods. A change in consumption when the price fluctuates — the elasticity of demand — is relatively low for an essential commodity like electricity, which has some usage that can't be controlled. We don't turn the refrigerator off, no matter the price. But some of us would do the laundry on nights or weekends if the price were discounted, and would turn up the temperature on our AC units during high-priced periods, especially if it were done automatically. If the overnight electricity price were cheap enough, we might even take advantage of thermal storage technology such as an air-conditioning unit that makes ice at night to store cold for use during the day or electric radiators that store heat energy. And we would certainly want to charge an EV

when electricity rates were lowest, as long as the car is ready to go when we are.

The true costs of providing electricity vary substantially over the course of each day, but standard utility flat rates do not provide incentives to use more electricity when it is cheaper to produce and less when it is expensive. Because they store electricity for future use, EVs should have a separate set of rates that encourage charging at the best times for the grid.

## RATES ADVANCE REGULATORY GOALS WHILE RECOVERING COSTS

Ratemaking has always been subject to an array of social goals, including economic development, universal service, support for different types of energy, load building, load shedding, and load shaping. Rates send signals that influence the behavior of all actors in the chain of supply and demand — consumers, producers, retailers and utilities.

A good EV rate design is a winner on many levels: making EVs more economical, making the electric system more efficient, improving reliability, curtailing emissions and reducing average unit costs of electricity — while better aligning the interests of the utility and energy users. But the right rate design options are not the same everywhere because they must take into account a long list of factors including market structure, load characteristics, meter technology, generation mix, economic drivers, distributed resources, climate variables and social goals. For example, a largely rural winter-peaking state like Maine, with relatively high industrial load and electricity sourced primarily from hydropower, natural gas and wind, may design rates quite differently from a state like Arizona, with a small industrial sector, high air-conditioning use, heated swimming pools and substantial solar energy development.

## CONSUMERS NEED TO UNDERSTAND UTILITY BILLS

Electricity costs flow from two large buckets — one for the generation of electricity by power plants and the other for its transmission and distribution. Both these functions used to be in the hands of Ohio utility companies. Beginning in 2001, generators were separated from regulated utilities and moved into a

regional competitive wholesale market. Utilities still own and operate the transmission and distribution systems in their service territories and are responsible for providing safe, reliable and affordable electricity. Electricity customers can buy energy from many retail marketers, although utility companies are required to sell energy to their customers at market-based rates, and most households have not switched to alternative providers.

In addition to taxes and required fees, regulated utility rates for residential customers have two basic components:

- **Monthly Customer Charge:** Fixed fees recover most costs that do not vary with usage, such as the connection, the meter, billing and other customer-based costs. These costs are the same whether or not there is an EV in the garage.
- **Volumetric Distribution Charge:** Residential rate designs usually assign a part of distribution costs to each unit of energy, without variation by usage volume or time of use. Such a flat rate has no influence on EV charging patterns.

Optimizing EV charging patterns requires prices that encourage customers to charge at the best times for the electricity system. Time-based rate options include:

- **Time of Use (TOU) rates:** Higher prices in peak periods and lower off-peak prices are more reflective

of actual costs. A successful TOU rate structure must have price variance large enough to incentivize drivers to charge their EV during the low-price periods and to avoid charging during high-price periods. A TOU rate design might have three pricing periods, such as on-peak during daytime hours, off-peak for overnight hours and weekends, and shoulder-peak hours in early morning and late evening. These periods could be modified between summer and non-summer to reflect seasonal changes in load patterns. Simple price ratios such as 1-2-3 might be used for the different periods.

Ideally, the time-variant rates should cover both utility supply and delivery. Such details should be finalized in regulatory proceedings, but all rates should be designed so that customers can easily understand them. As we will discuss, EV charging can receive separate rate treatment from other household usage.

- **Renewable Output Rates:** The variable output of renewable generation can have a dramatic effect on the resource mix at any time, and price signals can optimize use of zero-incremental cost energy. For example, electric rates could be reduced during peak periods of wind or solar output, and/or EV charging could be managed to coincide with it.
- **Real-Time Pricing (RTP):** In restructured states, where rates for commodity energy are unbundled



from delivery services, RTP programs can tie retail energy rates directly to wholesale market prices, changing each hour. The only state in which utilities offer residential RTP is Illinois (a statutory requirement enacted in 2007).<sup>76</sup> Because off-peak competitive energy prices often are very low — occasionally dropping to zero or below in the PJM market — RTP could reduce EV charging costs, particularly if combined with TOU distribution rates and price-responsive smart charging. While customers face potential price spikes under RTP, the experience over more than a decade in Illinois has shown that the vast majority of customers would see lower bills under a well-crafted optional program.<sup>77</sup> An in-depth discussion of residential RTP in Ohio is beyond the scope of this report.

- **EV-Only Rates:** In conventional rate design, one set of rates is applied to all usage on a customer’s meter. However, distinct rates could be applied to EV charging without need for a separate electric meter. Telematics can provide charging data from the EV or EVSE. Or with a smart meter, the utility could use disaggregation software to divide a household’s overall electricity usage into its end use components, allowing the volume and timing of vehicle charging costs to be estimated at sufficient accuracy for billing purposes.

Under a pilot program of utility PEPCO in Maryland, EV owners could choose to have their EV usage metered and charged separately or to have whole-house TOU rates. Most customers chose separate EV rates, and these TOU rates had a significant effect on charging behavior.<sup>78</sup> In Ohio, PUCO has approved a pilot program to provide TOU rates for EV charging to 500 customers of AEP Ohio.<sup>79</sup>

Time-variant rates incent drivers to charge at optimal times for the electric grid. There is no downside to enrolling EV owners automatically in EV-only TOU rates that provide a discount for overnight charging. But to fully capture the local system benefits of EV load flexibility, an additional technology will be needed: smart charging.

## POWERFUL PROSUMER POTENTIAL

The rise of electrified transportation coincides with the emergence of distributed energy resources (DER) as key elements of tomorrow’s energy mix. Wind and solar are becoming leading supply technologies while demand response and energy storage are beginning to help balance loads and improve efficiency. Smart grid deployment is creating a more resilient and decentralized electricity system, allowing a growing number of electricity customers of all sizes to become “prosumers” — not just consumers of electricity but compensated participants in DER markets. Fundamental changes to the utility concept itself are on the table, including moving from the traditional hub-and-spoke model with the utility at the center — acquiring, selling, and distributing power and energy to its customers — to a network platform over which the utility’s job is to maintain reliable service and facilitate energy resource transactions. EVs could become pivotal DER, using smart charging to optimize system load shape and discharging stored energy back to the grid in times of peak demand. Your car could even be a source of power for your home when the power goes out. Integrating all these innovations and trends to maximize system efficiency and reliability will be a key mission of the utility of the future.

## SMART CHARGING TURNS EVS INTO DISTRIBUTED ENERGY RESOURCES

Unmanaged charging whenever the owner plugs in the vehicle could be called “dumb charging.” But at relatively low concentrations of EVs plugged into standard 120V wall sockets (Level 1 charging), it poses no challenge to the electric grid. However, high neighborhood concentrations of Level 2 chargers could change system dynamics enough to necessitate costly upgrades. For example, earlier in this guide we described a typical scenario where commuters arriving home at 6 p.m. could set off a powerful neighborhood peak if they simultaneously plug-in, turn on the lights, crank up the A/C, and cook dinner in their electric ovens. A smart charging program

<sup>76</sup> <https://hourlypricing.comed.com/> and <https://www.powersmartpricing.org/>;

<sup>77</sup> See: Citizens Utility Board and Environmental Defense Fund, *The Costs and Benefits of Real-Time Pricing*, 3 (2017), [https://citizensutilityboard.org/wp-content/uploads/2017/11/20171114\\_FinalRealTimePricingWhitepaper.pdf](https://citizensutilityboard.org/wp-content/uploads/2017/11/20171114_FinalRealTimePricingWhitepaper.pdf)

<sup>78</sup> See <http://www.utilitydive.com/news/how-pepco-is-finding-ways-to-shift-demand-through-maryland-ev-pilot-program/434156/>; see tariff at p.13 of Pepco rate book: <https://www.pepco.com/MyAccount/MyBillUsage/Documents/MD%20Pepco%20Current%20Rate%20Schedule%20effective%2011182020%20Rider%20EVCDDCC.pdf>

<sup>79</sup> <https://cleanfuelsohio.org/public-utilities-commission-of-ohio-aep-settlement-agreement/>

would prevent this from happening, while ensuring that everybody's car is charged when they need it.

A smart charger communicates with the utility or central controller and adjusts charging levels based on real-time variables, creating a flexible distributed resource. Controlling variables could include overall electricity demand, local grid conditions, real-time output of renewable generation, marginal plant carbon emissions, and variable electricity prices under the customer's rate plan. This information is known to utilities or available from PJM, Ohio's regional grid operator. However, no applications are yet available that allow a driver to automatically start, stop, and schedule EV charging according to these variables. An applet to adjust charging in response to price signals and other customer settings is essential to taking advantage of flexible EV charging and could be developed or acquired by utilities.

By filling in the valleys of system load shape, smart charging would allow EV penetration to grow quickly with minimal need for expanded generation or distribution capacity. Smart charging also would:

- allow aggregated EV loads to be used as regulation service to address momentary fluctuations in voltage and power flows, turning chargers into grid-support resources for system operators.
- facilitate charging curtailment during critical peak periods to protect reliable service.
- hold down market energy prices.

As in other Direct Load Control (DLC) programs, the value of smart charging can be monetized as a demand response resource. Because the typical

Because the typical EV only needs to be charged during a few of the 22 hours a day that it is usually parked and plugged in, smart charge management wouldn't pose any problem for drivers.

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Smart charging aggregation programs are

beginning to be designed and piloted, though not yet in Ohio. As distribution system operators responsible

for maintaining reliable service at least cost, Ohio utilities should begin to test smart charging tools and invite EV owners to participate. Smart charging aggregations could also be organized by other entities with established customer relationships, including retail energy marketers, charge station companies, EVSE sellers, curtailment service providers, and vehicle manufacturers.

In northern California, BMW conducted a pilot to maximize use of solar energy and enhance grid stability. They found that by shifting load to optimal times, smart charging could increase an EV's zero-carbon travel by as much as 5,000 miles per year and save the grid \$325 in annual costs.<sup>80</sup>

### PRIORITIES FOR SMART EV POLICY

The imminent impact on the electric grid of rapidly growing EV loads shows the urgency of developing and testing charge-management strategies designed to:

- Maximize the efficient use of utility assets for EV charging loads.
- Reduce peak electricity market prices.
- Put downward pressure on electricity rates
- Minimize charging costs to EV drivers.
- Support EV adoption and market expansion.
- Improve air quality and decarbonize transportation.
- Advance equity and fairness to all communities.

Evolution of the generation mix may change the relationship between supply and demand. For example, southern California's millions of solar photovoltaic panels producing energy during the sunniest times of day make daytime workplace EV charging a good strategy for efficient use of the grid and renewable energy. Solar energy at large workplaces in Ohio could support daytime charging, while overnight charging would utilize our growing wind energy resources.

<sup>80</sup> See <https://bmwmovement.org/bmw-releases-chargeforward-report/>

# Part 6: Policies to Electrify Ohio

To date, Ohio has yet to implement a coherent EV policy to avoid expensive power consumption spikes, ensure equitable EV adoption or stimulate EV market demand. As the nascent EV market develops, policymakers should focus on the goals of stimulating EV market growth and helping consumers understand how to manage their charging behavior to reduce their bills and benefit the grid.

Ohio must bring the benefits of transportation electrification to all neighborhoods — with special attention to households that are unlikely to acquire an EV. CUB Ohio proposes these initial steps:

## **CONVENE A STATEWIDE OPEN STAKEHOLDER PROCESS TO DEVELOP A COMMON VISION FOR OHIO**

- Explore emerging transportation electrification issues and how they affect regulatory policy.
- Solicit the input of all interested stakeholder groups at the outset.
- Investigate state legal requirements and public utility commission authority.
- Develop a shared knowledge base and articulate a common vision for Ohio.
- Implement policy through utility-specific proceedings.

## **DEVELOP MANAGED-CHARGING PILOTS**

- Identify optimal circuits based on loads, EV clusters, charging behaviors.
- Design DLC programs that:
  - respond to local system conditions.
  - manage critical peak periods.
  - aggregate EV load as a Demand Response resource.
  - maximize renewable energy utilization.
- Test participation rewards and performance-based incentives.

## **IDENTIFY BARRIERS TO PUBLIC CHARGING**

- Consider alternative rate designs to encourage development of public charge stations.
- Test ways to manage charge behaviors, encourage

charge station deployment and customer-friendly operation.

- Consider benefits, costs, and ramifications of different ways to involve utilities in developing public-charging infrastructure.
- Participate in regional efforts to expand public-charging opportunities at optimal locations.

## **ESTABLISH TIME-BASED RATES FOR EV HOME CHARGING**

- Automatically enroll all EVs in EV-only time-of-use (TOU) rates, with these features:<sup>81</sup>
  - No separate meter required.
  - No extra monthly fees beyond the cost of service.
  - EV usage/charges listed separately on a single household bill.
  - Price differentials that offer meaningful savings between periods.

## **PROVIDE TARGETED INCENTIVES**

- Focus financial support on the most cost-effective and equitable programs to promote EV acquisition.
- Reduce acquisition costs where needed to make EVs more affordable to most car-buyers. Supplemental state purchase incentives should:
  - Only apply to vehicles priced below a reasonable threshold.
  - Be applied at point of sale.
  - Include used as well as new EVs.

## **DESIGN INNOVATIVE PROGRAMS TO ENSURE ALL CUSTOMER SEGMENTS BENEFIT**

- Identify areas in particular need of electrification benefits, such as environmental justice and lower- and moderate-income communities.
- Where personal EVs are unlikely to proliferate, deploy e-buses and other initiatives such as low-cost EV car sharing where residents have low or moderate incomes.
- Make EV charging available at multi-unit buildings and for drivers without access to a garage or permanent parking space.

<sup>81</sup> Enrollment assumes the utility is informed when a customer registers an EV acquisition. Other household usage would remain under its existing rate plan. Customers would retain the option to choose service under any applicable utility tariff. EV owners would save money by charging in off-peak periods, and other customers would benefit from a more efficient electricity system.

### DEVELOP ONLINE TOOLS AND APPS

- Automate charging response to price and other signals such as emissions and real-time renewable generation output.
- Offer shadow billing options to allow customers to compare current and historical monthly utility bills under different rate plans.
- Provide cost calculators to compare EV with ICE vehicle costs, given inputs such as miles driven, purchase price, financing, gasoline cost, electricity rate plans, and other variables.

### INTENSIFY OUTREACH AND EDUCATION

- Use utility communications for proactive customer engagement about EVs.
- Develop and distribute electricity rate and cost information materials for car dealers and their customers.
- Employ trusted independent third parties for targeted consumer outreach tailored to diverse communities.

## Conclusion: It's High Time for Ohio to Seize the EV Opportunity

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Transportation Electrification presents a unique opportunity for Ohio and it should become an immediate focus of public policy. The right set of policies can support the traditional regulatory goals of safe, reliable and affordable service, while advancing new goals of sustainability, decarbonization, efficiency and customer choice.

This paper has laid out a set of public interest goals for Ohio, including to:

- Support cost-effective and fair programs to encourage public and private transportation electrification.
- Protect Ohio consumers.
- Optimize system load shape through smart charging strategies.
- Aggregate EV loads as distributed energy resources (DER).
- Design and implement advanced electricity rate plans.
- Promote interoperability, customer choice, and seamless charging networks.
- Benefit lower- and moderate-income communities.
- Encourage investment, innovation, and market development.
- Integrate EV loads efficiently to reduce average per-unit energy cost.
- Work with other states on regional solutions.
- Ensure that all Ohio consumers, including those who don't drive EVs, will benefit from state EV policies.

Consumer protections for Ohioans must be at the heart of the public-interest goals stated above. The state must develop a plan based on our own laws, electric system characteristics, technology, market structure, regulatory framework and social/environmental objectives. While we may differ from others states in our final policy approach, we share the universal goals of growing and managing EV demand to create a more efficient, reliable and less costly electric system. It's a big job, and Ohio needs to start now.





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