ACCELERATING VEHICLE ELECTRIFICATION IN MICHIGAN

C2ES CLIMATE INNOVATION 2050

by

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The public and private sectors in Michigan are aligned behind goals of building out electric vehicle charging infrastructure and supporting consumer purchases of electric vehicles. Yet at the local level, physical and regulatory infrastructure build-out is only just beginning and faces challenges to meet the scale and pace of the growing market. Utilities, municipalities, site hosts, and other stakeholders are striving to balance short-run action with long-term needs for system-wide coordination and strategy. Simultaneously, massive shifts in supply chains, as well as assembly and production lines, are on the horizon. These changes, along with job opportunities in the installation and maintenance of charging infrastructure, will have significant implications for workers both today and in the future. The Inflation Reduction Act and the Infrastructure Investment and Jobs Act will provide billions in critical federal funding to support the transition to electric vehicles and will flow through state agencies over the next several years. Harmonized policies at the local, state, and federal levels will be needed to enable and support a successful transition to a zero-carbon transportation system. This brief summarizes key takeaways from our regional roundtable held virtually in Michigan in February 2022, and offers recommendations for state policy makers and companies to accelerate vehicle electrification in Michigan.

INTRODUCTION

REGIONAL ROUNDTABLES

Achieving net-zero emissions will require large-scale change across all sectors of the economy, and efforts to accelerate this transition are intensifying. Yet these changes—and climate change itself—have already begun to profoundly alter social, economic, and political realities in communities across the country. To chart a pathway to sustainable, long-term prosperity, communities must be able to leverage their unique strengths and capitalize on emerging economic opportunities, while addressing barriers that are often poorly understood outside of their communities. As companies make significant commitments and investments in low-carbon technologies and the facilities and workers who will produce them, policymakers have sought to identify approaches that can benefit communities and businesses alike. Doing

this well requires engaging directly with communities to understand not only their unique challenges, but, perhaps more importantly, the future they want to chart for themselves.

Our first roundtable of 2022, held virtually "in" Detroit, Michigan, brought together more than 70 stakeholders to consider ways to leverage Michigan's long history of success in the automotive industry with new advancements in technological development and deployment, policy, and workforce development to grow the electric vehicle (EV) industry and accelerate the pace of vehicle electrification in the state. This brief includes key takeaways from the event and a series of C2ES recommendations meant to align climate and economic objectives in Michigan. These recommendations are based on the roundtable discussion itself, as well as consultations with stakeholders before and after the event.

FRAMING THE DISCUSSION IN MICHIGAN

As the birthplace of the auto industry, Michigan has historically been home to the nation's leading and largest automakers. And as the global auto market shifts toward EVs, the pioneers of the internal combustion engine can also lead the way into the new electrified economy.

The private sector is already shifting toward this electrified auto future. Major automakers like Ford, General Motors, Stellantis, and Toyota have announced massive U.S. investments in scaling up battery, and vehicle production and zero-emissions vehicle (ZEV) producers like Tesla, Rivian, Lucid, Roush CleanTech, and others are rolling out battery-electric models assembled in the United States (See Appendix). Many of these companies' plans include billions of investments for Michigan sites in facility upgrades, new jobs, research and development, and other applications.

Michigan has demonstrated a strong commitment to electrification, and the MI Healthy Climate Plan highlights transportation electrification and expanded access to public transit options as essential decarbonization strategies to reach the state's goals.[1] To capitalize on that strategy, the plan establishes a goal of putting two million EVs on the road by 2030, and sets targets for electric model sales of at least 50 percent for light-duty vehicles, 30 percent for medium- and heavy-duty vehicles sales, and 100 percent for public transit vehicles and school buses sold in 2030.[2] In her 2022 State of the State address, Governor Gretchen Whitmer called on the state legislature to create an EV purchase incentive that could augment federal incentives to reduce the up-front cost burden on a new vehicle for many drivers, building upon the state's successful past deployment of the Volkswagen (VW) settlement funding.[3]

In Michigan, as throughout the United States, public charger siting decisions have largely been driven by early adopters and existing rates of EV adoption, which have prioritized affluent and majority-white communities.[4] But low-income communities and communities with large proportions of residents who cannot install home charging (e.g., renters, multi-family residents) can benefit comparatively more from access to public charging. These communities, alongside other historically marginalized communities like majority-Black communities, tend to be the most underserved by EV charging, preventing them from realizing the climate and air quality benefits associated with EV adoption.

With the passage of the Infrastructure Investment and Jobs Act of 2021 (IIJA, also known as the Bipartisan Infrastructure Law), major federal funding for public EV charging infrastructure and other low-carbon transportation infrastructure is coming to the states.[5] For example, through the National Electric Vehicle Infrastructure (NEVI) program, Michigan will receive more than $110 million in formula funding for building a public EV charging network along alternative fuel corridors over the next five years, a more than eleven-fold increase from the $9.7 million in VW settlement funding the state previously allocated to building out charging infrastructure.[6]

Additionally, the Inflation Reduction Act of 2022 (IRA) allocates $369 billion in funding for climate and clean energy investments, including tax credits for individual and commercial alternative fuel vehicles and charging/refueling infrastructure, as well as incentives to boost domestic production of batteries, electric vehicles, and critical materials. New tax credits will go far to help Michigan meet its EV goal. For instance, the previously owned clean vehicle credit will provide buyers up to $4,000 for the purchase of a pre-owned EV, and the expansion of the alternative fuel refueling property credit will allow commercial entities to claim a tax credit of up to 30 percent or $100,000 for each new charging station.

Through the Justice40 Initiative, at least 40 percent of the forthcoming federal funding will be targeted toward historically marginalized or underserved communities, a step forward for closing some of the accessibility gaps among these communities. However, it will still be neces-

sary for implementation at the state level and through public-private partnerships to intentionally target underserved communities to ensure the equitable distribution of the benefits of this funding.

Regional partnerships, including the REVMidwest coalition, demonstrate the value of coordination among regional actors to expand access to charging infrastructure and the viability of electrification for more drivers.[7] At the same time, state-level policy bolstered by support from the private sector can help local communities capitalize on the opportunity and ensure that all residents can access zero-emission transportation options.

The public and private sectors in Michigan are aligned behind goals of building out electric vehicle charging infrastructure and supporting consumer purchases of electric vehicles. Yet at the local level, the build-out of physical and regulatory infrastructure is only just beginning and faces challenges to meet the scale and pace of the growing market. Utilities, municipalities, site hosts, charging providers, automakers, policymakers, and other stakeholders are striving to balance short-run action with long-term needs for system-wide coordination and strategy. For example, short-run decisions and investments around siting public chargers, educating new and future EV drivers, and structuring purchase incentives must be balanced against long-run needs of building up system-wide grid resilience, implementing geographically consistent building codes, developing self-sustaining business models for charging, and securing the supply chain of critical minerals and component parts. If these long-term challenges are not considered, present-day policy risks entrenching path dependencies that will be harder to address down the line.

On the production side, massive shifts in supply chains, as well as an evolution of assembly and production lines, are on the horizon. For example, EVs do not require many of the component parts that make up the internal combustion engine supply chain, such as transmissions and engines, but do require significantly larger batteries with considerable inputs of critical minerals. These changes, along with job opportunities in the installation and maintenance of charging infrastructure, will have significant implications for workers both today and in the future. Michigan workers will be particularly affected, as one in four private-sector jobs in Michigan is either directly or indirectly tied to the mobility industry, and the Michigan automotive industry constitutes around 20 percent of the total U.S. automotive workforce.[8] In 2021, Michigan's production of engines and transmissions accounted for 9.4 percent and 24.6 percent of North American output, respectively, highlighting the need for proactive planning for the shift away from vehicles requiring these components.[9]

The growth of the domestic battery production industry could offer significant opportunities for skilled workers across the United States. New provisions in the IRA that incentivize domestic production of battery components and final assembly of EVs in North America include increasingly stringent eligibility requirements for the sourcing of battery components and assembly, which will have a profound impact on the trajectory of the domestic supply chain and EV manufacturing capacity. While these requirements could create challenges in the near-term, they will incentivize manufacturers to build up domestic capacity quickly to maintain eligibility. The advanced manufacturing production credit also provides refundable credits to domestic manufacturers for the production of battery cells, modules, and critical minerals of $35 per kilowatt-hour (kWh) in battery cell capacity, $10 per kWh in battery module capacity, or 10 percent of the critical minerals costs.[10] This provision will offer producers a significant financial incentive to bring their operations onshore, and could accelerate the development of a domestic battery supply chain over the next decade, adding thousands of jobs in the industry for skilled workers.

Shifts in demand among industries, skills required in automotive-related jobs, and entrepreneurial opportunities will necessarily have wide-reaching implications throughout the state's economy. While the groundwork has been laid for the electrification transition in Michigan, harmonized policies at the local, state, and federal levels will be needed to enable and support a successful transition to a zero-carbon transportation system.

Our Conversation

The roundtable discussion, which took place virtually over two days in February 2022, welcomed more than 70 stakeholders to explore themes relating to accelerating the deployment of charging infrastructure and building the future of manufacturing, installation, and the zero-emission workforce. Attendees expressed a shared optimism for the future of the ZEV industry, and the economic opportunity these industries can bring to the state

alongside their decarbonization potential for the American transportation sector. In particular, many expressed support for making Michigan a global hub for talent in the EV industry. At the same time, many attendees recognized the tremendous challenge that remains in harmonizing state, local, and federal policies to incentivize private investment, accelerate vehicle electrification, and grow the leadership of domestic manufacturers, while benefitting workers and communities.

This brief summarizes key takeaways from the roundtable and, building on insights from the event and dozens of conversations with stakeholders, provides recommendations developed by C2ES for companies and local, state, and federal policymakers to align economic and climate objectives by accelerating vehicle electrification in Michigan.

KEY RECOMMENDATIONS

C2ES has identified a series of policy recommendations that would support accelerating vehicle electrification in Michigan while aligning climate and economic development objectives, including through expanding access to charging infrastructure, future-proofing new and existing infrastructure, providing alternative low-carbon mobility options, and supporting the ZEV manufacturing workforce.

Expanding access to charging infrastructure

- Create purchase incentives, rebates, and tax credits for the purchase, installation, and operation/maintenance of electric vehicle service equipment (EVSE)
- Update building codes to require EV charging readiness in all new buildings
- Set technical standards across the industry, including software interoperability and standardized connectors
- Incentivize the installation of charging infrastructure for commercial medium- and heavy-duty vehicles
- Establish a state-level low-carbon fuel standard

Future-proofing new and existing infrastructure

- Set minimum standards on new charging equipment to prepare for future technologies
- Incentivize and enable installation and operation of bidirectional charging
- Promote strategic deployment of on-site energy storage

Providing alternative low-carbon mobility options

- Expand routes, last-mile connections, and accessibility of public transit
- Promote access to micromobility solutions

Supporting the ZEV manufacturing workforce

- Develop curricula to integrate problem-solving and project management skills training into K-12 education
- Promote collaboration between future employers and training programs to prepare new workers for success in the ZEV industry
- Promote working conditions that enhance productivity and quality of life while offering opportunities for growth and professional development
- Sponsor talented workers from the global economy to grow the American industry

OVERVIEW AND KEY TAKEAWAYS

Globally, the passenger EV segment is expected to grow from about 9 percent of total sales in 2021 to as much as 34 percent by 2030, with China, the European Union, and the United States leading the market.[11] By the end of 2022, the global EV stock is expected to surpass 26 million, a year-over-year increase of 62 percent.[12] Producers and suppliers face a tremendous opportunity to be early entrants to capture the exponentially growing demand and claim control of the market. Early movers enable the development of physical and regulatory infrastructure to support manufacturing capacity, supply chain development, and workforce training. This can create advantages by attuning infrastructure and supply chains to the needs of early movers, and enabling further innovation and costs reductions, including through learning by doing. While not insurmountable, later market entrants face challenges overcoming those advantages.

Though only 6 percent of U.S. vehicle sales, and less than 1 percent of Michigan vehicle sales, are electric (including plug-in hybrids), challenges surrounding

scaling up infrastructure and manufacturing already exist.[13] This roundtable focused on addressing those barriers, including accelerating the deployment of charging infrastructure and leveraging the talents of the Michigan workforce to build the future of the EV manufacturing and charging installation industries.

In the first session, we explored key technical barriers to facilitating broader charging access and EV adoption and how stakeholders can collaborate to address these challenges. We also discussed critical steps policymakers at all levels can take to enable growth in EV charging and adoption. Finally, we considered how to build upon federal and state investments in charging infrastructure to create sustainable, long-term business models for the EV charging industry.

In the second session, we explored opportunities to leverage growth in ZEV manufacturing and charger installation to create good jobs in Michigan. This included a discussion of what a shift toward ZEVs means for the workforce and how the industry can capitalize on this transition to create more opportunities for Michigan auto workers. We also discussed which skills are most in-demand in this growing industry, and steps stakeholders can take to ensure workers have the necessary training to develop these skills and succeed in the industry.

Throughout the discussion, roundtable participants highlighted the need to view each of the issues within a global, systemic context, rather than as discrete or isolated issues. For example, participants highlighted the equal need for access to EVs and alternative mobility solutions, like public transit, and identified structural barriers that often lead to marginalized communities being underserved by public transit in a similar way to those same communities being underserved by EV charging infrastructure. Relatedly, in the discussion surrounding manufacturing and workforce, participants pointed to other industries facing rapid technological shifts in recent decades as potential sources of best-practices or lessons learned, and highlighted challenges many American workers are currently facing in the context of a global workforce facing the same challenges.

While the discussion centered electric vehicles, participants emphasized that electrification is not a "silver bullet" solution to reducing emissions, and alternative technologies like hydrogen fuel cell propulsion may be better solutions in some sectors like long-haul freight transportation. Throughout the discussion, participants shared a belief that no single solution can address the full scale of the transformation; rather, electrifying the global transportation system will require a system-wide set of solutions.

ACCELERATING THE DEPLOYMENT OF CHARGING INFRASTRUCTURE

Impact on the power sector & need for collaboration across public & private sectors

Expanding electrification across the American transportation system will significantly increase electricity demand. Even with crucial progress in energy efficiency, the simultaneous electrification of other sectors like industry and buildings indicate that the impact of that demand growth on the power sector will be profound. In Michigan, meeting the state's goal of putting 2 million EVs on the road by 2030 could contribute to an 8 percent increase in annual electricity demand relative to 2020 levels.[14] EVs are more efficient than gasoline vehicles, and therefore reduce emissions even in most high-carbon generation regions. However, to make meaningful progress on decarbonization goals, this growth in demand must be met by carbon-free sources of electricity.

In addition to the increased overall generation required to support a mostly electric fleet, the varying types of charging needed, times of day when charging is utilized, and geographic distribution of the charging load will have significant impacts on the modern grid and must be considered in future planning decisions. A 2018 study from McKinsey found that, in scenarios where rates of EV adoption are geographically clustered, a 25 percent EV adoption rate would create a residential electricity peak demand increase of as much as 30 percent, absent demand management programs. It also found that the "highly volatile" load profiles of direct current fast charging (DCFC) stations required additional consideration, as in some areas a single fast charger could "exceed the peak-load capacity of a typical feeder-circuit transformer."[15]

Roundtable participants highlighted the effectiveness of utility-sponsored programs incentivizing off-peak charging through reduced time of use (TOU) charges and smart charging, while emphasizing the need for automakers to work with utilities on developing these smart charging systems to ensure effective and safe communication between the vehicle and the grid.

Similarly, participants expressed concern that the growing deployment of medium- and heavy-duty vehicles

will see instantaneous power draws for many charging use cases necessarily increase. In many locations, whether along highways, in densely populated communities, or in rural areas, the existing grid infrastructure may not be sufficient to meet the anticipated increase in load. Participants in the roundtable stressed the urgency of performing grid modernization updates now so that the grid can be ready to accommodate future technologies and increased loads. They also emphasized that successful grid modernization can only be accomplished through collaboration between automakers, utilities, charging providers, and state and local policymakers.

Performing these upgrades at the pace and scale required to keep up with the growing EV market will necessarily incur significant up-front capital costs and persistent operation and maintenance costs. Roundtable participants voiced concerns that these costs would be passed on to ratepayers who do not drive EVs, underscored by the fact that only around 1 percent of vehicles registered each year in Michigan are electrified.[16] Some participants recommended using a revenue-raising policy like a low-carbon fuel standard (LCFS) to put downward pressure on vehicle emissions while providing a funding stream for these necessary upgrades that will, in turn, enable further emissions reductions.

In Michigan, much of the public fast charger deployment is currently concentrated in urban-suburban areas with relatively high rates of EV adoption. However, participants stressed that rural areas, including communities in the Upper Peninsula, can also benefit from proactive DCFC charger installation, including by enabling rural drivers to switch to EVs, while also attracting EV drivers from other parts of the region during popular tourist seasons. Additionally, they highlighted that policymakers should consider ways to take socioeconomic disparities into account and prioritize supporting underserved areas.

Roundtable participants also highlighted the need for "future-proofing" near-term infrastructure by anticipating future technology needs that may be considered rare applications now but are expected to become mainstream in the mid- to long-term future. The discussion explored examples like higher capacity charging for larger and more efficient batteries, vehicle-to-grid/vehicle-to-anything (V2G/V2X, also known as bidirectional charging) technology, and public heavy-duty charging infrastructure for electric long-haul freight trucking applications. Participants highlighted the induction charging pilot in Detroit as a local example of technological innovation.[17] Each of these technologies may have limited applications in the present moment, but as EV adoption rates increase, and as these technologies become cheaper and more efficient, they may become the standard. To maximize the long-term utility of public investments and avoid the need for mid-term upgrades or replacements to infrastructure, policymakers must consider future technologies while fostering private-sector integration into planning and building considerations.

Participants across all stakeholder groups raised building codes or parking laws requiring make-ready infrastructure as possible solutions to the low availability of charging infrastructure in residential areas.

Optimal use cases for charging levels

Varying charging levels requiring different instantaneous power capacities can be deployed to maximize their effectiveness for a range of use cases while reducing their overall impact on the grid (**Table 1**).

When available, home charging is sufficient for the majority of daily use for most EV drivers. However, public DCFC is necessary to support drivers on extended trips, including for occasional road trips or work travel that may exceed the battery range on a given day. In many communities without access to home charging, DCFC may be seen as a solution, but is sub-optimal for daily charging because of its comparatively high cost, its significant load requirements, and its effects on battery degradation.

Level 2 charging, deployed in many home charging applications, may be overlooked in public charging applications because of its comparatively long charging times. However, roundtable participants suggested shared, public Level 2 charging depots for drivers who are unable to install home charging, particularly those living in densely populated urban areas, could be a suitable solution for daily charging. Public Level 2 charging is already significantly more accessible than DCFC in the Detroit area.[18] In addition to enabling urban EV uptake, this approach could help to reduce racial and income disparities among EV adopters, as many communities that would benefit most from expanded access to public, low-cost charging options may be majority-Black or majority-low and middle income.[19]

Table 1: Comparison of Instantaneous Power Requirements and Costs for Light-Duty Vehicle Charging in Michigan

TYPE	INSTANTANEOUS POWER PER VEHICLE (KW)	AVERAGE TIME TO CHARGE (BASED ON EV WITH 250 MILES OF RANGE)	AVERAGE MILES OF RANGE DELIVERED PER HOUR OF CHARGING	AVERAGE INSTALLATION COST PER CHARGER	AVERAGE COST PER KWH	BEST-CASE APPLICATION
Level 1	1	~20 hours (100%)	4–6	N/A	Residential: $0.12[1]	Residential, for daily at-home charging
Level 2	6–20, typically 6–7	~5 hours (100%)	12–54	Up to $3,000	Residential/ Commercial: $0.12[2] Public: Free, or $0.40–$0.80[3]	Residential, for daily at-home or workplace charging Commercial, fleet charging Public, local or in densely-populated urban areas
DC Fast Charging	50–120("Ultrafast" DCFC can be up to 350)	20–45 minutes (80%)	100–200+	$23,000–$100,000[4]	Public: $0.43+[5]	Public, along highways or in high-traffic "Ultrafast" for long-haul heavy-duty vehicles centers"

Sources: Jessica Shea Choksey, "What is DC Fast Charging?", J.D. Power, May 10, 2021, https://www.jdpower.com/cars/shopping-guides/what-is-dc-fast-charging*; Doug Vine, Power Infrastructure Needs for Economywide Decarbonization (Arlington, VA: Center for Climate and Energy Solutions, 2021),* https://www.c2es.org/document/power-infrastructure-needs-for-economywide-decarbonization/.

Passenger vs. commercial and light-duty vs. medium- and heavy-duty considerations

Electric vehicles have a variety of applications, across passenger commuting and local traffic, commercial light- and medium-duty fleets, and heavy-duty transport. Each of these applications requires drivers, owners, and operators to consider their unique needs, and participants stressed that stakeholders making charging infrastructure siting decisions should prioritize opportunities to maximize EV deployment relevant to each unique use case.

For passenger vehicles, most driving is local or commuting traffic, with the average Michigan driver traveling 12.9 miles to and from work each day, or around 125 miles per week—less than half of the average range of passenger EV models on the market today.[20] Drivers with home charging access generally perform around 75 percent of charging at home or work (Level 1 or Level 2), with public charging filling in the remaining gaps.[21] Often this home charging can take place overnight, when electricity loads and prices are otherwise low. However, individual drivers' routes may still be unpredictable, particularly when occasional longer trips are necessary. This creates challenges for EV deployment, which will require ensuring drivers feel confident that their EV is as useful and reliable as a gas-powered car. To address these concerns, public charging must be widespread, accessible, affordable, and visible. Highway rest stops and retail

parking lots are examples of sites conducive to public DCFC infrastructure that can fill in occasional charging gaps and build consumer confidence.

The need for reliable, accessible, and affordable charging is even more acute for EV drivers without access to home charging. In addition to the need to install more charging points in multifamily and rented homes, these drivers may benefit more from public or shared Level 2 charging located in neighborhoods or other more residential areas. One stakeholder suggested exploring the potential for office buildings with daytime workplace charging availability to make their chargers available at nighttime to communities as a possible solution to mitigate charging access gaps in these communities. The Department of Energy highlights the benefits to charger hosts as well, showing how employers with workplace charging can increase their charging station utilization rates by allowing public access to their charging infrastructure after business hours.[22] Policymaker and community collaboration can support sharing relevant information that could lead to similar company-community partnerships with innovative solutions.

In contrast, it is comparatively simple to predict and manage charging demand for many kinds of electrified commercial vehicles since these vehicles often follow predictable routes and times, and can be charged overnight when electricity costs are low. They can also park in company-owned depots, guaranteeing that there will be a place for them to remain while plugged in. Last-mile delivery vehicles are particularly well-suited to electrification, as their slow speeds and frequent stops allow them to take advantage of regenerative braking and efficiency relative to gas vehicles. Additionally, their routes are often concentrated in residential communities, where the impacts of avoided tailpipe emissions are significant, especially among vulnerable populations like children and elderly people.

However, as some roundtable participants emphasized, the up-front capital expense of building fleet-scale charging infrastructure can be prohibitive. State-level incentives to reduce the up-front cost burden can be beneficial to encouraging fleet electrification. Additionally, charging providers, utilities, and fleet operators should communicate with each other to identify where funding deployment could be most effective.

Tailpipe emissions and environmental justice

Roundtable participants stressed that, in addition to the climate benefits and economic development opportunities created by the shift to EVs, this transition can also bring significant health and environmental benefits, bolster climate resilience, and support environmental justice outcomes.

Tailpipe emissions from the combustion of gasoline and diesel include carbon dioxide, carbon monoxide, nitrous oxides (NOx), particulates (including PM2.5), volatile organic compounds (VOCs), ground level ozone, and other air pollutants that are hazardous to the environment and human health. Exposure to NOx and PM2.5 increases the risk of developing respiratory conditions like asthma, cardiovascular conditions, and chronic stress, and has recently been shown to contribute to poor health outcomes and higher risk of death from COVID-19.[23]

Due to systemic and structural racism through centuries of housing policy choices—including policies to divide majority-Black communities with interstate highways, siting decisions that put industrial facilities and construction zones closer to communities of color, and decisions prioritizing affluent, majority-white communities for service by public transit—many of these harmful tailpipe emissions are concentrated in historically marginalized communities, including majority-Black, indigenous, people of color (BIPOC) communities and communities with large immigrant populations (**Figure 1**).[24] These often overlap with other communities with heightened health, financial, and social vulnerability, including low-income communities, and communities with children, elderly people, people with disabilities, and people with pre-existing health conditions.[25] Targeting electrification to reduce tailpipe emissions in these communities will have a significant effect on the nation's most vulnerable and disproportionately affected populations.

Concentrated tailpipe pollution can often be found near highways, depots, warehouses, and ports. In these locations, many of the emissions are produced by medium- and heavy-duty vehicles, which make up a relatively small proportion of the overall fleet—in 2019, medium- and heavy-duty vehicles made up only 5 percent of vehicles on the road, but were the source of almost 25 percent of all transportation greenhouse gas emissions.[26] While zero-emissions technology development in the medium- and heavy-duty sector remains nascent relative to the passenger sector, options are available for almost all relevant use cases, and many electric versions of these

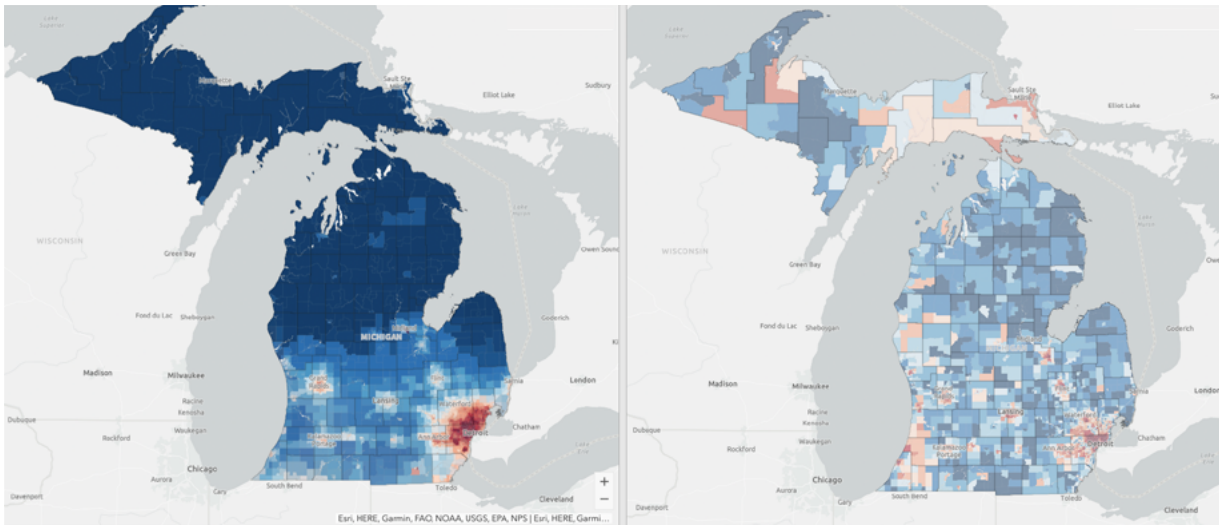
kinds of vehicles are projected to reach cost parity with combustion engine versions as early as model year 2027.[27] For hydrogen fuel cell vehicles, which could have advantages in the medium- and heavy-duty transport sector, and particularly for long-haul freight trucking due to short refuel times and fuel weight efficiency, price parity with battery electric models is expected to arrive in the 2030s and will be dependent upon the successful build-out of refueling infrastructure.[28]

Climate resilience benefits

Roundtable participants also highlighted the resilience benefits of electric vehicles. In particular, they emphasized the important role forthcoming V2X technology could play in grid resilience in the decades ahead.

In extreme weather scenarios where grid power is lost, EV owners can rely on their vehicle batteries to provide power to their homes, potentially keeping life-saving heaters or medical-devices online through the outage.

Figure 1: Comparison of concentrations of air pollution to counties with majority BIPOC populations in Michigan



----1b) NATA Respiratory Hazard Index

Percentile

- > 90 - 100 (Highest)
- > 80 - 90
- > 70 - 80
- > 60 - 70
- > 50 - 60
- > 40 - 50
- > 30 - 40
- > 20 - 30
- > 10 - 20
- 0 - 10 (Lowest)

----4b) Black, Indigenous, People of Color Population

Percentile

- > 90 To 100 (Highest)
- > 80 To 90
- > 70 To 80
- > 60 To 70
- > 50 To 60
- > 40 To 50
- > 30 To 40
- > 20 To 30
- > 10 To 20
- 0 To 10 (Lowest)

Source: MI EJScreen (EGLE) https://egle.maps.arcgis.com/apps/opsdashboard/index.html#/7cbda57ca72a4815b715bf835b2cbbc2.

In this way, EVs could replace the need for gasoline or diesel home generators, which produce greenhouse gas emissions and can be harmful to human health. Roundtable participants highlighted a climate change-fueled derecho in December 2021 that left hundreds of thousands of customers across the state without power for up to three days.[29] For context, a Ford F-150 Lightning with Extended Range battery capacity and bidirectional charging capabilities has an 80 kWh capacity, enough to meet the basic power needs of a mid-sized home for up to three days.

With more advanced "smart-charging" software and deeper system-wide integration of V2G technology, EVs could also be a resource for stabilizing the overall power system, providing backup power when peak loads are high or when renewable generation is low, reducing the need for additional fossil-fueled generation capacity to come online. This could help to mitigate load management challenges associated with the additional 8 GWh of expected load nationwide due to widescale electrification. However, current barriers to V2G adoption, including conflicting technical standards regarding inverter operation, prevent the widescale adoption of this technology. Participants suggested greater coordination between utilities, automakers, and policymakers as a solution.

Roundtable stakeholders also mentioned economic shocks associated with volatility in global oil markets and the benefits of a majority-electric fleet in protecting households against the impacts of gasoline price spikes. Just weeks after the roundtable event in February 2022, Russia's invasion of Ukraine and the resulting 90-cent (27 percent) spike in average Michigan gasoline price per gallon over the following month while electricity prices remained relatively stable put this scenario to practice.[30]

MANUFACTURING AND WORKFORCE

Economic Opportunity

Globally, the automotive market is shifting toward zero-emission vehicles. This is particularly relevant in the passenger market, where EVs are taking an increasing share of the market each year. Historic trends in demand growth for EVs in China and Europe have significantly outpaced similar growth in the United States, demonstrating a significant global market opportunity in addition to the growing domestic one.[31]

Buoyed by recent technological improvement, expanding choices for electric models, and political pressure from countries committing to phasing out gas-powered vehicles, global EV sales are expected to rise at an increasing rate throughout the remainder of 2022. Projections forecast that as many EVs will be sold in the second half of 2022 as were sold in all of 2021.[32]

In the United States, General Motors and Ford have committed investments of $35 billion and $50 billion to electrification and autonomous vehicles by 2025, and they, along with other major automakers like Toyota and Volkswagen, plan to build new facilities to onshore EV battery production.[33] All-electric automakers like Tesla, Rivian, and Lucid Motors are similarly investing in expanding assembly facilities while partnering with suppliers to vertically integrate battery production and supplies of critical materials and components, with the goal of securing their supply chains in a tight market. The IRA places heightened urgency and financial incentives upon rapid development of a domestic battery and EV manufacturing supply chain, with stringent and escalating requirements on battery component sourcing as requisites to eligibility for both the clean vehicle tax credit and direct support to grow domestic manufacturing capacity.

Participants in the roundtable emphasized that, as companies develop these facilities, they must capitalize on talent from both the existing American workforce, as well as the global workforce, to truly be competitive in acquiring top talent.

As with other emerging industries, early leaders in the EV market hold tremendous power to shape both the future of the industry and the competitive landscape of the market for decades to come. For example, investments in top-tier workforce development can build a geographically concentrated talent pipeline, producing advantages for companies capable of tapping into that resource. Capital-intensive supply chain investments can also create and leverage other interdependencies, including shared infrastructure, that can further embed competitive advantages for early movers. An example of this phenomenon is the current concentration of global critical minerals refining capacity in southeast Asia.

The production and distribution demands of the EV industry are significantly different from those of the internal combustion engine industry. In comparison to the more than 200 moving parts in an internal combustion vehicle, an EV has fewer than 20.[34] While EVs still have traditional onboard needs like power windows, heated seats, and adjustable mirrors, the mechanics of the car are simple—relying on battery cells and electric

motors—with most of the performance supported by software. Thus, many workers that have previously supported the production and installation of component parts like transmissions and exhaust systems, as well as workers that have specialized in final assembly, will see significant changes to their roles and the skills required to succeed in them.

At the same time, new supporting industries in the EV service equipment (EVSE) sector will face a tremendous opportunity for growth, as demand for their products and services will correspond to growth in demand for EVs. Charging equipment, both public and residential, is needed at a massive scale to support the burgeoning industry, but in many cases, infrastructure build-out must lead and anticipate growth in EV uptake to even enable that uptake to happen. This will create new careers in charger manufacturing, installation, and maintenance, and provide thousands of jobs for trade workers like electricians and other contractors.

Workforce Readiness

Roundtable participants emphasized that in addition to the new technical skills many workers will need to develop to succeed in the future EV workforce, they will also need to grow "soft" skills in communication, problem solving, creativity, and other areas. These skills are particularly useful to people who work simultaneously with hardware and software, which can help workers to excel in EV and EVSE system design.

Participants stressed that while these "soft" skills are supported in technical and trades programs, they must also be integrated into school curricula for grades K-12, as they are best developed early and throughout a child's school career. Starting skills training early can help students prepare for a variety of careers and may even help them make decisions of which kind of post-secondary education to pursue, whether a two-year or four-year college degree, a trade program, or an apprenticeship.

In some trades, the workforce is rapidly aging, setting the industry up for a major demographic transition in the coming years. In the electrical trades, for example, more than 40 percent of the workforce is eligible to retire currently or will be in the next decade.[35] To fill the impending employment gap, future employers can prepare students for success in the industry by supporting skills development throughout K-12 schooling. They can also make training programs accessible to high schoolers and recent graduates, through providing scholarships, expanding eligibility, introducing younger students to key concepts, and other actions.

Roundtable participants also emphasized social stigma as a challenge in recruiting young workers to trades. They referenced unfavorable societal perceptions of those working in the trades relative to those working in jobs requiring a four-year degree. While this perception started to shift during the pandemic, an interest gap remains between trade school and four-year college applications.[36] Participants called for employers, educators, and parents to support efforts to fight this negative stigma and encourage students to consider potential trade careers. Doing so would feed workers' interest in the industry and make it possible for them to develop early career readiness.

Training and Retention

In addition to recruiting new workers to enter the field, roundtable participants highlighted the need to support mid-career training programs and "upskilling" programs. As the day-to-day requirements of automotive sector jobs evolve with the EV industry, existing workers may find gaps in their knowledge or skillsets. Roundtable participants identified employer-sponsored training programs and professional development, as well as external courses and certificate programs, as essential elements for workers in transition to preserve high-quality, good-paying jobs.

Participants also raised worker retention as a necessary priority for employers in the sector. With record job-switching occurring in the "Great Resignation" (also known as the "Great Reshuffling") powered by low unemployment and some side effects of the COVID-19 pandemic, employers must respond to the needs of current employees and adapt to the shifting landscape of the job market to capture the cost and talent benefits of retaining workers.[37]

POLICY RECOMMENDATIONS

EXPANDING ACCESS TO CHARGING INFRASTRUCTURE

Create purchase incentives, rebates, and tax credits for the purchase, installation, and operation/maintenance of EVSE

The IIJA will provide millions of dollars in federal funding for the purchase and installation of public charging and alternative fueling infrastructure in Michigan, but more is needed to both enable EV market growth and meet anticipated demand for charging infrastructure. State-level incentives can augment federal support by offering purchase incentives for installation and rebates or credits for the operation and maintenance of fleet charging, public Level 2 or DCFC, and home charging infrastructure.

Roundtable participants pointed out that the nascent and challenging nature of the EVSE industry can mean that even when chargers are installed and available, they may still be broken or otherwise unusable and maintenance may be difficult if the original installer has closed its business. The most recent survey of real-world charger functionality, which took place in the San Francisco Bay Area in March 2022, found that of 181 public charging stations, 23 percent were "nonfunctioning," and only half of the chargers completed a payment transaction upon first attempt.[38] State incentives can support the maintenance of chargers by new companies and can ensure that chargers remain accessible and operational for their full useful life. To enable this, state incentives must include funding eligibility for maintenance in addition to construction.

In Michigan, public charging infrastructure has thus far been largely administered via the Charge Up Michigan program, which has a goal of completing a statewide charging network by 2030. Through that program, the state has deployed millions of dollars in grants funded by the state's allocation from the Volkswagen diesel settlement for public charging stations. For private charging infrastructure for businesses and homeowners, most charging equipment rebates are offered through utilities rather than through state programs, and can range from rebates of $300 to $5,000 per Level 2 port.[39] **Further state incentives should maximize deployment of both publicly and privately accessible infrastructure in communities with high rates of car ownership but low access to home and public charging infrastructure in order to close gaps in adoption rates among these communities.**[40] In particular, the funds should prioritize areas underserved by both existing state programs and utility incentives. Many of these underserved communities are low- and middle-income communities or are disproportionately communities of color. Expanding access in these communities can help to close income- and race-based gaps in access to EVs.

Rural areas should also be prioritized for public fast charging infrastructure to ensure rapid adoption among the state's drivers with the highest annual vehicle miles traveled (VMT). A recent study found that the top 10 percent of U.S. drivers by gasoline consumption accounted for 32 percent of all U.S. gasoline consumption. These drivers were more likely to live in rural areas and have lower average income levels than current EV drivers, meaning targeting policies to incentivize rural drivers to switch to EVs would have an outsized effect on road vehicle emissions.[41]

Update building codes to require EV charging readiness in all new buildings

At the municipal level, building codes should be updated to ensure new buildings are prepared to host EVSE before construction begins to prevent costly and time-consuming retrofits. Currently, 16 communities in Southeast Michigan have some type of EV ordinance.[42] For example, the City of Ann Arbor's Unified Development Code requires new site plans for City Council—generally new projects or major expansions—to provide EV parking infrastructure, whether fully installed, EV-ready, or EV-capable.[43] Similar requirements beginning with municipal infrastructure and extending to commercial and/or residential infrastructure can accelerate the pace at which EV charging is deployed and adopted. These requirements should be adopted throughout the state and harmonized to the best extent possible to reduce compliance costs and challenges, thereby maximizing efficiency for developers.[44]

In multifamily residential applications, residents' access to EVs is dependent on a property's EV readiness, as individual residents generally do not have control over the necessary structural and electrical upgrades required to install charging infrastructure. Proactive EV readiness can also save costs—Cal Matters found in 2021 that

retrofitting buildings for EV charging access can be four to ten times more expensive than proactively installing it at the time of construction.[45] **Municipal building codes should require all new development to make a proportion of parking spaces at least EV Ready, meaning they have all required electrical hardware for the future installation of charging equipment, with additional requirements for charger installation in areas where utilization is projected to be highest and where communities have the highest percentage of residents who do not own their homes/buildings** (**Box 1**).

Finally, streamlining the permitting process for EVSE installation can reduce costs and cut project timelines, making infrastructure more accessible and affordable for homeowners, developers, and installers.

Set technical standards across the industry including software interoperability and standardized connectors

As new EV technologies emerge and evolve, greater coordination is needed among automakers, charging providers, and utilities to allow vehicles and infrastructure to be most accessible and deployable by the broadest number of companies and consumers. Roundtable participants raised charging speeds and connectors as particular areas of focus, as utilities and charging providers must anticipate these developments in forthcoming vehicles to adequately serve them. In addition to hardware, participants raised concerns about software interoperability between providers, particularly the accessibility of closed-network software to drivers accustomed to open-network access. For example, drivers who normally use only one or two network providers may find their charging access limited when traveling outside of their normal driving radius.

That said, regulation requiring harmonized technical standards and charging network interoperability is in its early stages, and over-regulation of an emerging market may hamper technological advancement or deployment at scale. **Automakers, utilities, and charging providers should therefore engage in voluntary coordination, which policymakers can and should facilitate for greatest cooperation through regular stakeholder convenings and digital information sharing.**

INCENTIVIZE THE INSTALLATION OF CHARGING INFRASTRUCTURE FOR COMMERCIAL MEDIUM- AND HEAVY-DUTY VEHICLES

Establish a low-carbon fuel standard.

A performance standard for the carbon intensity of a fuel can be used to reduce emissions from transportation and support the electrification transition while maintaining flexibility for individual producers.

In 2010, the Midwestern Governors' Association convened a low-carbon fuel policy advisory group to consider both a federal program and a regional pro-

Box 1: EV parking space charging strategies

The International Code Council offers the following widely-accepted strategies building codes can include for new buildings: EV-Capable, EV-Ready, and EVSE-Installed.

- **EV-Capable**: Parking spaces that have the electrical panel capacity and conduit installed during construction to support future implementation of EV charging with 208/240-volt (or greater), 40-ampere (or greater) circuits. This strategy ensures the reduction of up-front costs for EV charging station installation by providing the electrical elements that are difficult to install during a retrofit. Anticipating the use of dual-head EVSE, the same circuit may be used to support charging in adjacent EV-Capable spaces.
- **EV-Ready**: Parking spaces that have full circuit installations of 208/240-volt (or greater), 40-ampere (or greater) panel capacity, raceway wiring, receptacle, and circuit overprotection devices. This strategy provides all required electrical hardware for the future installation of EVSE. Anticipating the use of dual-head EVSE, the same circuit may be used to support charging in adjacent EV-Ready spaces.
- **EVSE-Installed**: EVSE that is fully installed from the electrical panel to the parking space.

Source: International Code Council, Electric Vehicles and Building Codes: A Strategy for Greenhouse Gas Reductions (Washington, D.C.: International Code Council, 2021), https://www.iccsafe.org/wp-content/uploads/21-20604_COMM_EV_Strategy_RPT_v5.pdf.

gram. The group recommended a credit trading system covering all producers of transportation fuels, including electricity, and highlighted the expanded flexibility and effectiveness of programs integrated across states.[46] The recommendations were never implemented, and current attempts to establish a low-carbon fuel standard (LCFS) in the Midwest are often met with skepticism from some environmental groups, who raise concerns that the policy could incentivize agricultural development for biofuels on natural land, producing further carbon emissions and causing other harmful environmental impacts.[47] This could limit the political feasibility of further attempts to establish a LCFS designed without mention of biofuel development on natural land.

In 2022, the MI Healthy Climate Plan called for the establishment of a clean fuel standard (CFS), reviving the policy and updating its applicability to the current transportation system. A CFS differs from other fuel standards as it would set definitions of "clean" fuels rather than relying solely on a fuel's carbon intensity. While this policy could allow the state to set stricter guidelines around the development of biofuels, it might reduce compliance flexibility and could raise compliance costs to producers, which may be passed on to consumers in the form of higher fuel prices.

The state should establish a low-carbon fuel standard requiring carbon intensity of fuels to be reduced 30 percent by 2030 and 85 percent by 2050 from a 2020 baseline, consistent with the state's existing climate goals. Additionally, as much of Michigan's fuels are imported from outside the state, Michigan can lead the way for the region to establish a LCFS and integrate the programs, including trading systems, across states.[48]

A LCFS can also generate revenue from the sale of credits, which should be used to fund grants, rebates, and zero-interest loans for the construction, operation, and maintenance of public charging infrastructure.

FUTURE-PROOFING NEW AND EXISTING INFRASTRUCTURE

Set minimum standards on new charging equipment to prepare for future technologies

Newly constructed charging equipment must be prepared to serve vehicles for at least 5–10 years of its estimated useful life. Equipment installed today should not only meet the needs of current vehicles but also the anticipated new technological needs of future vehicles.

Federal, state, and utility funding incentives for public and commercial EVSE should specify eligibility criteria that include design for future technologies, including bidirectional charging capabilities, faster charging times, and other expected developments.

Automakers, charging providers, utilities, and local policymakers should share forthcoming technological innovation, particularly when it will require upgrades to existing infrastructure.

Incentivize and enable installation and operation of bidirectional charging technology

Bidirectional charging is essential to facilitating the use of EVs as resilience, as well as mitigation, solutions. When the power goes out due to extreme weather or other events, EV owners can use V2X capabilities to power their homes in lieu of fossil fuel-powered generators. Additionally, with access to V2X capabilities and telematics, grid operators could utilize the storage capacity of EVs for electricity generated when prices/demand are low or excess production of renewable electricity is available, then deploy the stored energy later to offset peak loads.

Currently, only a few models of EV on the market have V2X charging capability, although automakers have made commitments to expand its utilization throughout the market by mid-decade. Some models with V2X capability are only compatible with the charger produced by the same manufacturer; others are compatible with most chargers. All compatible chargers require inverters to enable them to distribute energy as well as receive it, adding to the cost of the equipment.

State and federal EVSE incentives should prioritize equipment with bidirectional charging capabilities and should make the additional purchase and installation costs eligible for funding under the incentives. Additionally, utilities should prepare to integrate V2X capabilities from EVs, and automakers and charging providers should communicate with utilities and policymakers to help them anticipate grid integration.

Promote strategic deployment of on-site storage

On-site energy storage can reduce instantaneous pressure on the grid when multiple fast chargers are used simultaneously. Where load is already high, and where additional space is available at charging sites—as in large retail parking lots, in rural areas, and along highways—on-site storage solutions should be installed alongside charging infrastructure. Under the proposed minimum

standards and requirements for projects funded under the National Electric Vehicle Infrastructure (NEVI) Formula Program, on-site storage construction and maintenance costs are eligible for federal funding.[49] **State funding for new fast charger construction should also include eligibility for these projects, and the state should work with utilities to identify optimal sites for storage deployment when submitting its NEVI plan to the federal government and deploying state funding.**

PROVIDING ALTERNATIVE LOW-CARBON MOBILITY OPTIONS

Reducing VMT is as essential to reducing emissions as electrification. Providing low-carbon mobility options reduces fuel consumption (whether gasoline or electricity), mitigates congestion, improves air quality, and expands access to transportation for residents who cannot afford a vehicle or who are unable to drive. Across Michigan, 7.5 percent of households have no vehicle, and 33.8 percent of households have just one car, meaning many residents need access to alternative mobility solutions.[50] The MI Healthy Climate Plan includes a goal of expanding public transit access 15 percent each year.

Expand routes, last-mile connections, and accessibility of public transit

Through the IIJA, Michigan is slated to receive at least $1 billion over five years in formula funding to improve public transportation options across the state.[51] **The distribution of these funds should focus on areas with high population density, particularly areas with high proportions of low-income residents and residents of color, to expand lines, increase frequency of service, and when possible, reduce fares.** Planners should also consider changing commuting patterns due to the increased prevalence of remote work and other factors relating to the pandemic.

Promote access to micromobility solutions

Shared micromobility solutions, like electric scooters and bicycles, can fill transit access gaps for those who are able to ride them, and can connect residents to services that would otherwise require a car trip or bus ride. **Cities in Michigan should deploy shared micromobility solutions and offer free or reduced fare to low-income riders and riders not served by existing transit routes.**

Surrounding infrastructure can limit the accessibility of micromobility options. **In addition to deploying bikes and scooters, cities should invest in safe, accessible bike lanes, pedestrian crossings, and traffic control devices to protect riders.**

SUPPORTING THE ZEV MANUFACTURING WORKFORCE

As the auto manufacturing industry shifts to leading-edge ZEV production inputs and techniques, the workforce supporting it will shift as well. The evolving design, production, testing, installation, and maintenance of EVs and EVSE will all increasingly require software skills in addition to hardware skills, often within the same role.

Roundtable participants, from companies to labor groups, emphasized that many of the skills that prepare workers to succeed in these rapidly changing industries can and should be developed outside of direct reskilling/upskilling programs. At the same time, employers spoke to the factors that influence worker hiring and retention, and how they have changed over time with the pandemic accelerating that pace of change. In a global ZEV market, the talent pipeline must also be global to ensure companies can attract top innovators and workers in their fields.

Develop curricula to integrate problem-solving and project management skills training into K-12 education

Roundtable participants highlighted the need to develop creative problem-solving skills and project management skills in primary school, even before students decide on their future career paths. Michigan's Top 10 Strategic Education Plan includes the guiding principles that, "All students are encouraged to express their creativity…" and that "All students are provided every opportunity to achieve the broadest range of life dreams."[52] Additionally, the state's Academic Standards include learning objectives for each grade level and in each major subject area that touch upon problem solving skills. However, additional skills that can be more concretely applied to project management and creative problem solving in a work environment should be integrated into the curriculum. Examples of these can be found in the Career Technical Education Career Ready Practices and Career Clusters Framework currently being utilized in a limited capacity in trade school applications.[53] **The Michigan Department of Education should work with prospective employers and educators to develop learning objectives for every level consistent with career readiness skills and should integrate these objectives into academic standards and curricula throughout the state's K-12 school systems.**

Promote collaboration between future employers and training programs to prepare new workers for success in the ZEV industry

Similarly, to prepare students for the evolving needs of the ZEV industry, employers and educators should collaborate to identify prerequisite skills for entry into the industry. **Companies should provide funding for vocational training programs for high school and early-career students to augment public education offerings. Additionally, the Michigan Department of Education should actively seek input from companies in industries directly or indirectly relating to the ZEV industry to forecast skills and training needs and proactively address them in new curriculum development.**

Promote working conditions that enhance productivity and quality of life while offering opportunities for growth and professional development

The "Great Resignation" or "Great Reshuffling"—the pattern of significant numbers of workers quitting their jobs and either switching roles or careers or leaving the workforce entirely—has demonstrated that in the current labor market, where more jobs exist than job seekers, workers hold more power than before and can choose jobs that meet their needs in terms of wages, hours, conditions, opportunities for growth, and other factors.[54] In order to attract and retain high-quality talent, employers must provide high-quality working conditions and respond to employees' needs.[55] **To compete for top talent, companies will need to offer a living wage, competitive benefits, and professional development opportunities to attract new workers and offer existing workers a path to advancement.** Benefits like on-site childcare and employee resource groups that address barriers to workforce participation for groups like low-income, immigrant, or single-parent workers, as well as workers with nontraditional education or career paths, can open opportunities to bring in new, diverse talent.

Sponsor talented workers from the global economy to grow the American industry

As of 2018, 7 percent of Michigan's residents were born in another country, with 40 percent of immigrants possessing a college degree or higher; around 10 percent of workers in Michigan's professional, scientific, and technical services industry were immigrants.[56] Roundtable participants representing companies, local government, and trade/labor groups highlighted how diverse global talent can bolster American innovation and global competitiveness. In order to compete in a global market and produce top-quality, highly competitive goods and services, companies must draw from the global workforce to attract top talent.

Michigan-headquartered companies should work with the state and federal government to attract global workers and provide a path to citizenship.

C2ES RESOURCES

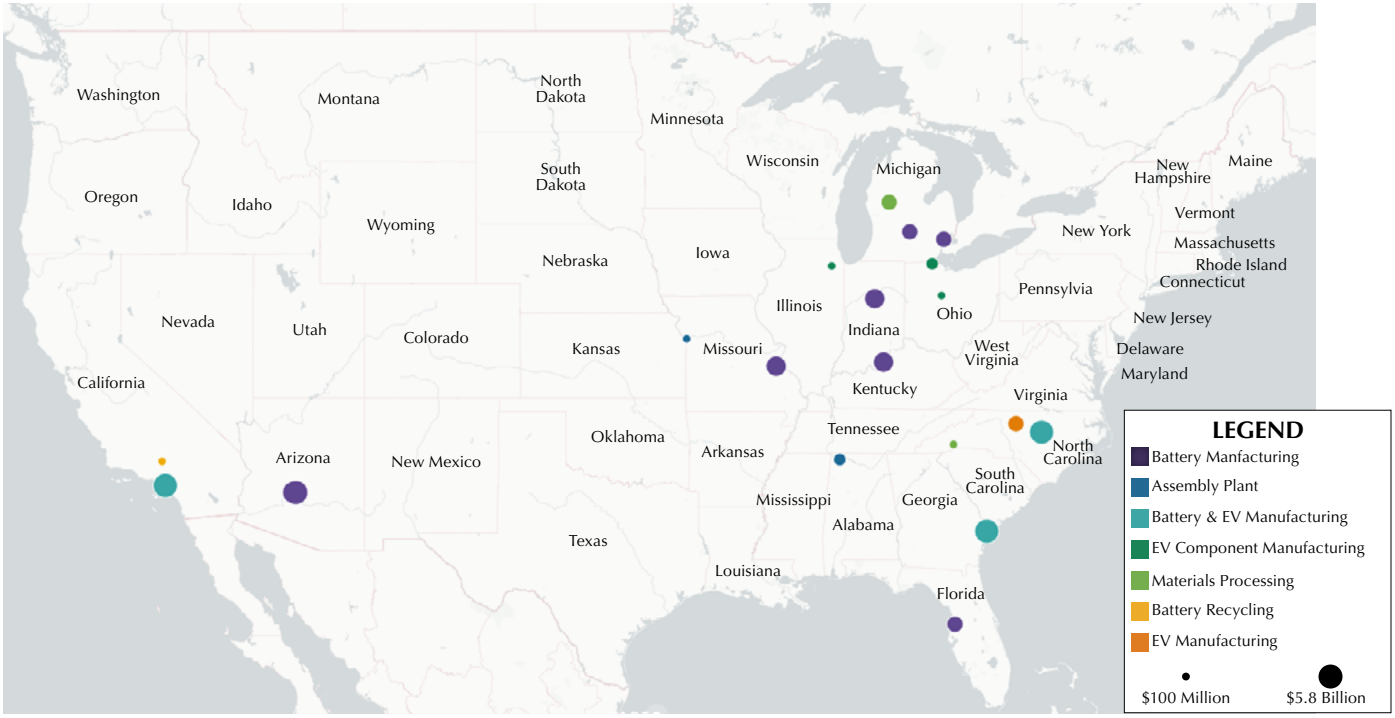
Getting to Zero: A U.S. Climate Agenda

Investing in West Virginia's Future: Aligning Climate and Economic Development

Investing in Arizona's Future: Driving Equitable, Low-carbon, Economic Growth

Fueling a Low-Carbon Future in Utah: The Role of Hydrogen

APPENDIX: MAP OF NEW EV AND BATTERY FACILITIES ANNOUNCED IN 2022



This map shows the approximate location and type of EV assembly and/or battery manufacturing facility announced between November 2021 and October 2022. The size of the dot corresponds to the projected capital investment, and the color corresponds to the type of facility.

Source: "Automakers' Bold Plans for Electric Vehicles Spur U.S. Battery Boom," Federal Reserve Bank of Dallas, last modified October 11, 2022, https://www.dallasfed.org/research/economics/2022/1011; *White House, "FACT SHEET: President Biden's Economic Plan Drives America's Electric Manufacturing Boom," press release, September 14, 2022,* https://www.whitehouse.gov/briefing-room/statements-releases/2022/09/14/fact-sheet-president-bidens-economic-plan-drives-americas-electric-vehicle-manufacturing-boom/. *Full dataset available upon request.*

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