MICHIGAN ECONOMIC
DEVELOPMENT CORPORATION

What's Next Is Electric

How people are powering electrification to create economic opportunity

MICHIGAN IMPACT REPORT

Four dimensions of electrification. Driven by transportation.

Transportation has been a driving force in economic expansion for the past century, impacting many business sectors and supporting a diverse base of well-paying jobs – in Michigan and across the country.

Now, as next-generation transportation technologies become mainstream, Michigan is in a prime position to provide the workforce, leadership and innovation to manufacture electric vehicles (EVs), upgrade infrastructure and modernize the energy grid. The impact of electrification will also reduce carbon emissions, improve quality of life and position Michigan to be more competitive in a global economy.

WHAT WE DRIVE

Consumers are creating a strong market for EVs and automakers are committed to expanding EV options to compete with internal combustion engine (ICE) vehicles on performance, reliability, safety and ownership costs.

- The types of EVs are expanding.
- The driving range of EVs is increasing.
- EV cost of ownership is lower than ICE vehicles.

WHERE WE LIVE

Electrification is a foundation for growth in cities, suburbs and rural areas where products and services are being developed, manufactured, installed and maintained.

- Growing demand for energy-efficient appliances and residential solar.
- Upgrading residential properties for EV charging.
- Potential for reverse or bi-directional charging.

WHERE WE WORK

From large factories and light manufacturing to small businesses and agriculture – electric power generation is expanding local and global demand for products and services.

- EV market expanding for commuting and service vehicles.
- More charging stations at business locations.
- Making businesses more energy independent.

WHERE WE TRAVEL

Alternative energy and electrification can bring power to every region of the country and make travel more convenient, more productive and more affordable.

- More charging stations along travel routes.
- EVs matching ICE vehicles for driving range.
- Access to power for travel-related vehicles and equipment.

200+ years of electrification is propelling economic growth into the future.

The shift to a fully electrified transportation sector is built on two previous restructurings of American life – the electrification of homes and the proliferation of the personal automobile.

1800–1920
Era of Invention

1800
Battery invented.

1830
Motorized, battery powered "horseless carriage."

1830 to 1845
Electric relay, electric motor and fuel cell and electric telegraph.

1870 to 1890
Incandescent light bulb, vacuum cleaner, electric refrigerator, air conditioner, electric streetcar, hydroelectric plant large electricity generating windmill.

1920–1940
Era of Power Transmission and Product Innovation

1920 to 1935
The Federal Power Commission (FPC) was established, Tennessee Valley Authority and New Deal legislation.

1932 to 1945
Almost half of American farms had electricity, up from 11% in 1932. Population, productivity and income growth results in rural areas.

1940–1970
Era of Electrical Infrastructure

1940 to 1970
Electricity access and number of automobiles transform daily life.

Federal Highway Act of 1956 funds the interstate highway system.

Expansion of electrical grid and power generation systems included: coal, natural gas, nuclear, wind and solar.

1970–2000
Era of Expansion and Personalization

1970 to 2000
Expansion of electric and battery-powered products and devices.

Modern electric and hybrid cars.

Residential solar systems.

2000–2035+
Era of Efficiency and Acceleration

GROWTH OF ELECTRIC-POWERED DEVICES

DEMAND FOR ELECTRIC VEHICLES

2000 to 2035+
More EVs with longer range; more vehicle charging stations with faster charging capabilities; modern infrastructure to support mobility; more government and private investment.

A positive impact across the state.

Electrification is not just a sustainability goal, but an economic engine. With ambitious goals, investments, incentives and practical innovation, Michigan is realizing the benefits of an energy-driven economy in every area of the state.

	Developments and Innovations	Creating Opportunities	Economic Impact
Manufacturing	Michigan is seeing "a high-tech gold rush" of investment in all EV-related goods, including demand for the semiconductors to power EVs.	The Inflation Reduction Act (IRA) promotes localized production with incentives for battery pack and cell assembly as well as mineral processing. The CHIPS and Science Act aims to boost domestic manufacturing of semiconductors and other advanced technologies.	EVs increase demand for components to be manufactured locally — decreasing supply chain risk and lowering the carbon footprint for transporting goods.
Infrastructure	More EVs accelerate electrical grid modernization — including updates to physical infrastructure and advances in electricity generation and distribution. Adding EV charging stations will lead to upgrades to aging substations and transformers, and new electrical services.	The Infrastructure Investment and Jobs Act (IIJA), CHIPS and Science Act, and IRA will bring infrastructure improvements plus incentives for domestic manufacturing of semiconductors, advanced battery cells, packs and related minerals, wind turbines, solar panels and several other green industries.	EVs will require more charging stations along transportation corridors, at company fleet centers, at residences, workplaces and anywhere they park their vehicles. Chargers will add manufacturing jobs to build, install and maintain the equipment — and drive advancement in charging technology.
Decarbonization	The grid will use more renewable energy and create a statewide demand for energy generation systems.	EVs can dramatically reduce emissions and accelerate improvements to the electrical grid, creating immediate economic impact and long-term support for economic growth.	Vehicles are regularly replaced — and new cars will drive a significant portion of the U.S. economy to decarbonize. New jobs in renewable energy generation will foster training programs, and other ways to provide skills in development, manufacturing, sales and service.
Energy	Innovations in a range of energy generation technologies will create a highly competitive and dynamic industry well into the future. The potential to generate energy on-demand and store peak energy will significantly lower costs and make business more competitive.	Increased employment of people to build, install and maintain charging stations in Michigan and modernize the electrical grid. As automakers produce more electric cars and trucks, new manufacturing plants will be built to meet the growing demand for EV batteries.	Employment opportunities for software developers, electrical engineers, electronic engineers and chemical engineers, as well as other science and technology-related skills.

Why demand for EVs is taking off

More people choosing EVs: As more EVs are sold and rented, people are becoming more familiar with the advantages of EVs.

A wider range of EVs: Nearly every major car company has EVs in their lineup — and EVs are available in every automotive category, from subcompacts to sedans, SUVs and trucks.

The cost of ownership: Ownership cost for EVs can be less than ICE vehicles when factoring in purchase price, fuel and regular maintenance.

Driving range is increasing: The average range of a fully changed EV is over 300 miles, comparable to an ICE vehicle – and range is increasing in every new model car year.

More charging stations: The number of charging stations will more than triple over the next few years – and become more available in residential buildings, office buildings and businesses.

By 2030, EVs could be 40% of all passenger car sales in the U.S.

Looking ahead. Leaping forward.

In moving society toward clean energy solutions on commercial and rural properties, studies show **people think consumers/businesses and the government should play an equal role**.

More than 60% of U.S. electricity generation comes from natural gas, coal and other fossil fuels, which means EVs are responsible for some carbon emissions but are still **cleaner than ICE vehicles**.

Wireless charging on roadways is an innovation in charging technology — being demonstrated in Electreon's roadway in Detroit.

In the U.S., the number of next-generation AC ports for faster EV changing will more than **21 million** by 2030.

MICHIGAN ECONOMIC DEVELOPMENT CORPORATION

To learn more, visit **www.michiganbusiness.org**.

Guidehouse INSIGHTS

White Paper

Economic Opportunities of Transportation Electrification

The Rush to Increase High Tech Manufacturing Will Spur Job Growth and Economic Development

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Introduction

To limit the increasing and potentially irreversible effects of climate change, a growing international effort aims to reduce global greenhouse gas emissions, primarily in the form of CO_2. The US accounts for more than 11% of global CO_2 emissions,[1] with only about 4% of the world population. Reducing that share is increasingly a priority of federal and state governments, corporations, and individuals. With the shift toward a carbon-free economy comes opportunity in the form of new and expanding industry.

Central to this transformation is the electrification of transportation. This is because the vehicles on the roads are regularly replaced, and that natural turnover is an easy opportunity to decarbonize a significant portion of the US economy. The steps required for widespread EV adoption will also result in the transformation of other industries, in particular electricity generation and distribution.

The investments that will ensure a smooth transition to electrification, and broader efforts to decarbonize the US economy, will lead to new areas of job growth and economic expansion. Building EVs will also unlock new opportunities in local manufacturing, as demand for advanced lithium ion batteries increases. These new EVs will be charged by a grid that uses more and more renewable energy, an industry also undergoing domestic manufacturing growth. Charging EVs will require more charging stations across the country and people to build, install, and maintain this equipment. This movement will also modernize the grid, a transformation that will lead to long-overdue updates to the physical components of the country's electrical infrastructure and new ways to manage distributed power flows.

[1] European Commission, EDGAR – Emissions Database for Global Atmospheric Research, "GHG Emissions of All World Countries," 2023, **https://edgar.jrc.ec.europa.eu/report_2023**.

Why Are EVs Critical to Decarbonization?

Transportation accounts for 28% of greenhouse gas emissions in the US, with 58% of that total attributed to light duty vehicles. Compared with other sectors, automobiles have a steady turnover rate, and for the most part, an EV offers the same functionality as an internal combustion engine (ICE) vehicle. Replacing fossil fuel-powered electric generation plants with renewable energy is difficult and complicated in comparison. Likewise, improving the overall energy efficiency of commercial and residential buildings takes decades to achieve meaningful emissions reductions. Significant progress is being made in those sectors, but transportation, and especially the approximately 15 million new light duty vehicles purchased every year, represent one of the fastest and most straightforward ways to reduce emissions.

Furthermore, both the requirements to successfully achieve a transition to electrified transportation and the opportunities created by a growing fleet of EVs will advance the decarbonization of other industries such as energy production. Much like how the growth of the automobile fueled America's postwar economic expansion, the shift to electric mobility stands to reshape and revitalize American manufacturing.

Historical Overview of Progress in Electrification and Mobility

The shift to a fully electrified transportation sector is built on two previous restructurings of American life—the electrification of homes and the proliferation of the personal automobile. Less than 100 years ago, large parts of the US still did not have home electricity, especially not in agricultural communities. Nebraska Senator George Norris sought to elevate the rural standard of living and bring the same prosperity that electricity had endowed to cities. Senator Norris cosponsored the Rural Electrification Act, which was signed into law as a part of the New Deal. This allowed farming cooperatives to take out low interest loans to build out power lines and other electrical infrastructure. By the end of the 1930s, the price per mile of power lines in rural areas had dropped by over 50%.[2] Widespread electrification not only brought comfort and light to millions of Americans but also increased agricultural productivity and brought long-term growth in population, employment, property values, and incomes for these rural areas, just as Norris intended.[3]

Likewise, automobiles were initially a product for the wealthy. The market developments that made cars attainable and even necessary for most homes in the US came well after they were established as a viable means of transportation. One major factor was the advances in manufacturing spurred by Henry Ford. Mass production made automobiles more affordable for average Americans. Following World War II, the automobile enabled America's postwar expansion, spurred on by the Eisenhower administration's expansion of the interstate highway system through the Federal-Aid Highway Act of 1956. Federal funding allowed for new high speed routes between cities and made commuting easier, shifting the American dream to a new house in the suburbs with a pair of cars in every garage.

The expansion of electricity access and the standardization of the automobile for everyday transportation were radical changes in American life. Spearheaded by Henry Ford in Detroit, Michigan, America became the global heart of early automobile development and industrialization. From 1890 to 1930, Detroit's

[2] Tim Sablik, "Electrifying Rural America," *Econ Focus*, Federal Reserve Bank of Richmond, 1Q 2020, **https://richmondfed.org/publications/research/econ_focus/2020/q1/economic_history**.

[3] Joshua Lewis and Edson Severnini, "Short- and Long-Run Impacts of Rural Electrification: Evidence from the Historical Rollout of the U.S. Power Grid," *Journal of Development Economics* 143 (March 2020), **https://doi.org/10.1016/j.jdeveco.2019.102412**.

population grew from fewer than 200,000 residents to 1.5 million,[4] largely due to its contributions to the automobile industry. With the expansion of new industries comes the opportunity to create regional hubs with a self-sustaining ecosystem of businesses, training centers, and R&D efforts, all feeding into each other to drive economic development and job growth. The cities and states that can foster a supportive environment for the industries related to EV growth will be positioned to make the most gains, with long-reaching benefits.

EVs Are at the Center of a US Manufacturing Renaissance

Policies such as the Infrastructure Investment and Jobs Act (commonly known as the Bipartisan Infrastructure Law), the CHIPS and Science Act, and the Inflation Reduction Act (IRA) aim to revitalize American manufacturing through infrastructure improvements and incentives for domestic manufacturing of semiconductors; advanced battery cells, packs, and related minerals; wind turbines and solar panels; and several other green industry components. While these products are relevant to markets beyond the transportation sector, they are also inextricably linked to automobiles. The high powered electronics in EVs and charging equipment will require higher volumes of newer semiconductors. New wind turbines and solar panels will generate renewable energy to power these vehicles, and the batteries that power EVs will also be used as stationary energy storage, capturing renewable energy when the sun is shining or wind is blowing so that EV owners can charge up whenever they need.

The environmental benefits of zero tailpipe emissions are one reason for a global trend toward increasing legislation aimed at promoting EVs. While these emissions benefits are a major factor in the proliferation of EVs, mobility electrification offers other significant advantages over ICE vehicles as well.

New Jobs and Industries

The IRA of 2022 encourages the transition to EVs through clean vehicle credits for purchasing qualifying new and used vehicles, but that is only one aspect of a bill that aggressively incentivizes domestic manufacturing. Another central piece of the IRA is incentives for manufacturing advanced lithium ion battery packs and cells, as well as for processing and refining the critical minerals used to make these batteries. While a move to co-locate battery plants near vehicle assembly plants was already underway when the bill passed, the IRA has accelerated the development of domestic battery manufacturing. Battery production capacity in the US is currently around 72 GWh[5] and is expected to grow to approximately 900 GWh by 2027.

Manufacturing of EVs and their components is not the only industry that will be kick-started in the coming years. The proliferation of EVs will require more chargers to be in more places—not just fast chargers built along transportation corridors but also chargers at company fleet centers, and in people's homes, workplaces, and anywhere they park their vehicles. Those new chargers require manufacturing jobs to build the equipment, electricians to help install them, and technicians to maintain and service them throughout their use. Manufacturing these EVs and EV chargers requires significant advanced technology. The incentives in place to electrify mobility create domestic jobs up and down the supply chain.

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[4] City of Detroit, *Proposed Broadway Avenue Local Historic District*, 2005, **https://detroitmi.gov/sites/detroitmi.localhost/files/2018-08/Broadway%20Avenue%20Local%20HD%20Final%20Report.pdf**.

[5] Alessandra R. Carreon, "The EV Battery Supply Chain Explained," RMI, May 5, 2023, **https://rmi.org/the-ev-battery-supply-chain-explained/**.

Federal incentives from the IRA and the Bipartisan Infrastructure Law, along with the ongoing trend of nearshoring, have already resulted in a manufacturing boom in the US, not just for battery plants but also for green energy such as wind and solar power. States with legacy manufacturing capabilities like Michigan are seeing a "high tech gold rush" of investment[6] in all these areas, including demand for the semiconductors that are ever-present in modern electronics. From companies already located in Michigan like Hemlock Semiconductor and CHT, to new investments such as KLA's $200 million second US headquarters[7] and SK Siltron CSS's $300 million manufacturing facility,[8] the development and expansion of the semiconductor industry presents plenty of opportunity for economic growth. Michigan is also the site of the World Economic Forum's first US Center for Advanced Manufacturing, a hub for developing these new and expanding industries.

Transforming the Electrical Grid

The expectation of more EVs on the road is putting the advancement of the electrical grid on fast-forward. Unlike other recent developments in the way electricity is used, like LED light bulbs and heat pumps, EVs create more electrical demand. While the US has ample power for these EVs, the prospect of where and when they charge is pushing the energy sector to rapidly update its physical infrastructure as well as the way utilities manage the generation and distribution of electricity. EV charging will require more power in new places, meaning upgrading aging substations and transformers as well as building out new electrical services. These changes, along with the growth in renewable energy generation, have already resulted in long lead times for high voltage transformers[9] and investments in expanding transformer production, which will be an ongoing challenge as both EVs and renewable energy continue to grow.

[6] Jennifer Eberbach, "'A High-Tech Gold Rush': Silicon Valley Firm Says Michigan Is the Place to Be," *Livingston Daily*, November 12, 2023, **https://www.livingstondaily.com/story/news/local/community/green-oak-township/2023/11/12/silicon-valley-firm-says-michigan-is-the-place-to-be/71514660007/**.

[7] KLA Corporation, "KLA Announces Grand Opening of $200 Million Second Headquarters in Ann Arbor, Michigan," November 5, 2021, **https://ir.kla.com/news-events/press-releases/detail/415/kla-announces-grand-opening-of-200-million-second**.

[8] Governor Gretchen Whitmer, "Whitmer and SK Siltron Bring Semiconductor Supply Chain to Michigan with New Bay City Facility," September 1, 2022, **https://www.michigan.gov/whitmer/news/press-releases/2022/09/01/whitmer-and-sk-siltron-bring-semiconductor-supply-chain-to-michigan-with-new-bay-city-facility**.

[9] Nicole Jao, "U.S. Renewable, Grid Battery Projects Battle Transformer Shortage," Reuters, November 15, 2023, **https://www.reuters.com/business/energy/us-renewable-grid-battery-projects-battle-transformer-shortage-2023-11-15/**.

The US Needs to Boost EV Adoption

In 20 years, the way drivers interact with their vehicles will be radically different. With broad access to charging at home, work, and anywhere they park, drivers will not need to think about stopping to fill up at the gas station like they used to. Instead, they will start nearly every day with plenty of battery and will be able to quickly top off at a fast-charge station when traveling longer distances. Charging will be an everyday activity, and most people will forget that they once had to take time out of their days to gas up.

The benefits of EVs stretch beyond the convenience of skipping the gas station. The switch to EVs can drastically reduce the carbon output of the entire transportation industry, even when the electricity used still generates greenhouse gas emissions. More than 60% of US electricity generation comes from natural gas, coal, and other fossil fuels,[10] which means EVs are responsible for some carbon emissions but are still cleaner than ICE vehicles. The average US ICE vehicle produces 12,594 pounds of CO_2 equivalent in a year, compared with only 2,727 pounds of CO_2 equivalent for an all-electric vehicle.[11] Additionally, unlike with an ICE vehicle, the emissions associated with an EV can get cleaner over the lifetime of the vehicle as the grid moves toward higher levels of renewable energy.

As more people switch to EVs, the shift will bring about changes elsewhere in the economy as well. Promoting EV adoption requires more than just economic incentives; it will also require making charging easy and convenient wherever people drive, and making EVs as affordable as their ICE-powered equivalents.

Drivers Need to Be More Familiar with EVs

According to a survey by the Michigan Economic Development Corporation, 53% of the US general population has never driven an EV or only been a passenger. Most drivers do not have the first-hand experience with EVs that might help alleviate common concerns about them, such as range. Considering that more than 75% of all vehicle trips are 10 miles or less, many households would rarely have to worry about their EV's range.[12] Most EVs have more than enough range for daily commuting,[13] but range anxiety persists.

Greater familiarity with EVs would help consumers understand how infrequently range factors into daily driving and make them aware of the built-in mapping and routing systems already available to help find charging stations and plan longer trips. They would also experience the subjective benefits of EV ownership, like smooth acceleration and quiet operation.

As more EVs are sold, more new owners and their passengers will gain experience, but building this familiarity will take time. To push this further, EV manufacturers need to better articulate the advances in

[10] U.S. Energy Information Administration, "What Is U.S. Electricity Generation by Energy Source?" Last updated October 20, 2023, **https://www.eia.gov/tools/faqs/faq.php?id=427**.

[11] U.S. Department of Energy (DOE), Alternative Fuels Data Center, "Emissions from Electric Vehicles," 2022, **https://afdc.energy.gov/vehicles/electric_emissions.html**.

[12] DOE, Office of Energy Efficiency & Renewable Energy, "FOTW #1042, August 13, 2018: In 2017 Nearly 60% of All Vehicle Trips Were Less than Six Miles," August 13, 2018, **https://www.energy.gov/eere/vehicles/articles/fotw-1042-august-13-2018-2017-nearly-60-all-vehicle-trips-were-less-six**.

[13] Shannon Osaka, "The Obsession with EV Range Is All Wrong," *Washington Post*, July 7, 2023, **https://www.washingtonpost.com/climate-solutions/2023/07/07/ev-range-anxiety-battery-myth/**.

technology that make EVs a viable transportation option, which will help increase the average consumer's familiarity with EVs and make them more confident in the decision to purchase an EV.

Making It Easy for Consumers to Switch to EVs

For EVs to become the norm, they need to be cheaper and more convenient to own than ICE vehicles. While EVs might be cheaper to drive on a per-mile basis and save money over the lifetime of the car, they have a significantly higher upfront cost. In July 2023, the average transaction price of a new vehicle was $48,334, while the average transaction price of a new EV was $53,469.[14] The IRA attempts to rectify this with up to a $7,500 tax credit, but that incentive varies based on several factors, such as what percentage of the critical materials for the battery are from the US, which can easily confuse consumers. Incentives are important to ensuring that EVs are manufactured in the US, but they should also be focused on making EVs easy for consumers to buy.

Charging Will Be Easy and Everywhere

Today, there are more than 145,000 retail fueling stations in the US[15] but only around 9,000 DC fast charging stations.[16] The ubiquity of gas stations means that anyone can drive almost anywhere and know they will be able to fill up on the way, while EV drivers need to plan ahead before a road trip. For comparison, the US has about 104 gas pumps per 1,000 miles of road, but only 22 EV ports.[17] The number of chargers is growing rapidly, however, with 23,000 ports added between 2022 and 2023 alone. An alliance of seven major automakers, including General Motors (GM) and Stellantis, announced plans to install 30,000 fast charging ports by 2030,[18] and $25 billion in cumulative investment has already been announced for the manufacturing of public charging units.[19] In addition, innovative wireless charging solutions, like Electreon's roadway in Detroit, are already being deployed in the US to help address charging demand and keep drivers on the road while their EVs are charging. Parity between EV chargers and gas stations is still decades away, but a public charging network is emerging that can support the EV transition.

[14] Cox Automotive, "Kelley Blue Book Analysis: New-Vehicle Transaction Prices Up Less Than 1% Year Over Year, Smallest Increase in Decade," August 16, 2023, **https://www.coxautoinc.com/market-insights/kbb-atp-july-2023/**.

[15] NACS, "Key Facts about Fueling," April 6, 2023, **https://www.convenience.org/Topics/Fuels/The-US-Petroleum-Industry-Statistics-Definitions**.

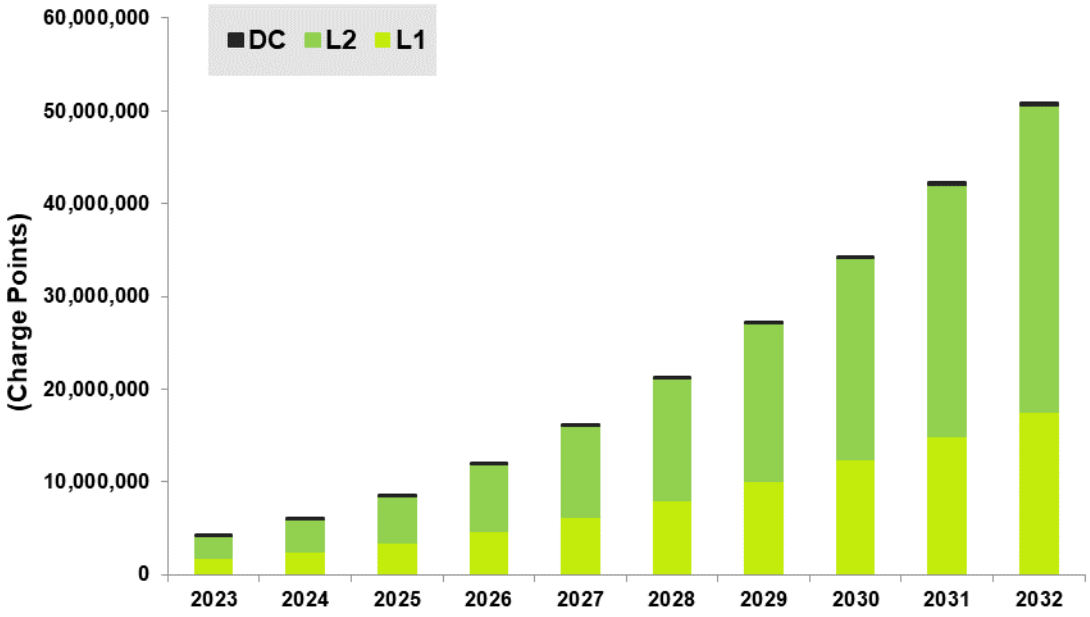
[16] DOE, Alternative Fuels Data Center, "Electric Vehicle Charging Station Locations," accessed February 19, 2024, **https://afdc.energy.gov/fuels/electricity_locations.html#/find/nearest?fuel=ELEC&country=US&ev_levels=dc_fast**.

[17] Coast, "EV Charging vs. Gas Station Density in the U.S.," August 2023, **https://coastpay.com/ev-charging-stations-vs-gas-stations-comparing-density-in-the-u-s/**.

[18] Jack Ewing, "G.M. and Other Automakers Will Build 30,000 Electric Vehicle Chargers," *New York Times*, July 26, 2023, **https://www.nytimes.com/2023/07/26/business/energy-environment/electric-vehicles-fast-chargers-automakers.html**.

[19] Heather Boushey, "Full Charge: The Economics of Building a National EV Charging Network," White House Briefing Room, December 11, 2023, **https://www.whitehouse.gov/briefing-room/blog/2023/12/11/full-charge-the-economics-of-building-a-national-ev-charging-network/**.

Figure 1 Installed Charge Points by Technology, US: 2023-2032



(Source: Guidehouse Insights)

More fast chargers are coming, but it will still be years before EV batteries can charge as fast as filling up an ICE vehicle. Mitigating this downside will require Level 2 (L2) chargers, which can fully charge an EV in 4-10 hours, in more places. Because these chargers are more affordable to purchase and install, they will proliferate more quickly than fast chargers. L2 charging will also be a key factor in the electrification of fleets, as recognized by Ford's initiative with Xcel Energy to install 30,000 fleet charging ports by 2030.[20] Guidehouse Insights forecasts the number of L2 charging ports in the US will grow to more than 21 million by 2030. L2 chargers can be installed in parking garages, parking lots, next to buildings, attached to light poles, and generally anywhere that can be electrified. Charging has the unique ability to meet drivers where they are, as opposed to forcing drivers to come to a specific location—eventually making charging as convenient and second nature as locking car doors.

[20] Ford Newsroom, "Ford Pro and Xcel Energy Collaborate to Support Installation of 30,000 EV Charging Ports for Business Fleets by 2030," December 5, 2023, **https://media.ford.com/content/fordmedia/fna/us/en/news/2023/12/05/ford-pro-and-xcel-energy-collaborate-to-support-installation-of-1.html**.

What Opportunities for Innovation Does Expanded Electrification Bring?

The electrification of mobility brings new challenges, and not just for automakers and drivers. Charging the growing numbers of EVs will require upgrading and modernizing the electrical grid and will present new opportunities where EVs can help advance other sustainability trends like renewable energy. Transforming the grid will need support, which means increased demand in related professions including installation, service, and maintenance of charging infrastructure.

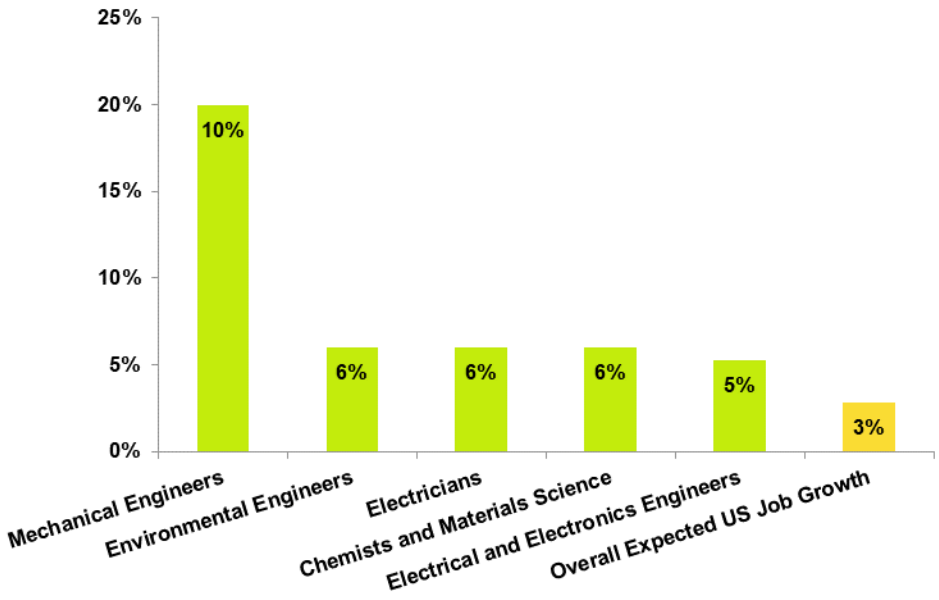
Creation of a Sustainable Electrical Grid

When people get home from work in the summer, they may turn on their air conditioning, start a load of laundry, turn on the TV, and turn on the oven to make dinner. When this happens on the scale of entire neighborhoods or city blocks, which it does quite frequently, it puts enormous strain on the aging power grid in the US. If everyone driving home now adds charging their EVs as well, these issues will be exacerbated. The EV revolution will spur the necessary modernizations to meet this increased demand for electricity.

Preparing the energy grid for the future requires distributing energy in a local, dynamic, and granular way. Utilities will leverage new resources close to where power is used to supplement existing, larger generation facilities. These resources include behind-the-meter energy storage, such as batteries installed in a home. While primarily used for backup power or to store excess solar energy to use later in the day, these batteries can also alleviate strain on the grid and contribute power during a demand spike. This is possible with EV batteries as well. An EV with the right charging equipment can return power to the grid, functioning as a flexible energy resource when called upon. This vehicle-to-grid (V2G) process can make it so that eventually, EV owners might earn money by lending power to utilities, reducing the cost of vehicle ownership.

If more homes have behind-the-meter batteries or V2G power becomes common, it will also unlock new potential for designing electricity generation. The supply of solar energy is highest during the middle of the day, but peak electrical consumption happens later. Distributed energy systems can fix this by storing excess solar energy when it is cheap and plentiful, and then discharging that energy later in the day when more is needed. The same is possible with wind farms, which tend to generate the most energy at night. Even without V2G, EV charging can be managed to take advantage of excess renewable energy generation, maximizing the use of green energy and minimizing the strain on existing fossil fuel generation. A project of this scope requires government-funded investment for renewable power resources, as well as buy-in from local utilities to support the effort. As with every other aspect of electrification, such projects will spawn innovative industries and solutions, requiring new jobs and training to meet the new demand for a smart grid.

Figure 2 Expected US Job Growth Rate, Selected Industries: 2022-2032



(Source: Guidehouse Insights; data from U.S. Bureau of Labor Statistics)

Onshoring of Battery Manufacturing

The overall adoption of EVs requires a retooling and rethinking of domestic manufacturing, shifting from the previous paradigm of global supply chains. EVs have spurred a recent push to build more components locally, both to decrease the risk of supply chain issues and to reduce the carbon footprint of transporting components like batteries. The IRA promotes localized production by establishing incentives for battery pack and cell assembly as well as mineral processing. More than 900 GWh of battery manufacturing capacity in the US has been announced through 2027. These projects include GM's Ultium plant in Tennessee, which is creating 1,700 battery manufacturing jobs;[21] BMW's $800 million battery plant investment in South Carolina, expected to create 1,170 jobs;[22] and Our Next Energy's $1.6 billion battery manufacturing campus in Michigan, which will create more than 2,000 jobs. The push for self-sufficiency in EV supply chains as US mobility is electrified will spur the creation of thousands of new jobs to support the transition.

Manufacturing jobs created by the electrification transition are not limited to EVs and EV batteries. The CHIPS and Science Act aims to boost domestic manufacturing of semiconductors and other advanced technologies.[23] Intel has already announced a $20 billion investment in semiconductor fabrication in Ohio, which the company estimates will create 7,000 jobs in addition to the 3,000 jobs involved in construction.[24] This type of technology is foundational to EVs and chargers, and expanding the production

[21] Ultium Cells, "Spring Hill, Tennessee," accessed February 19, 2024, **https://www.ultiumcell.com/our-locations/spring-hill-tn**.

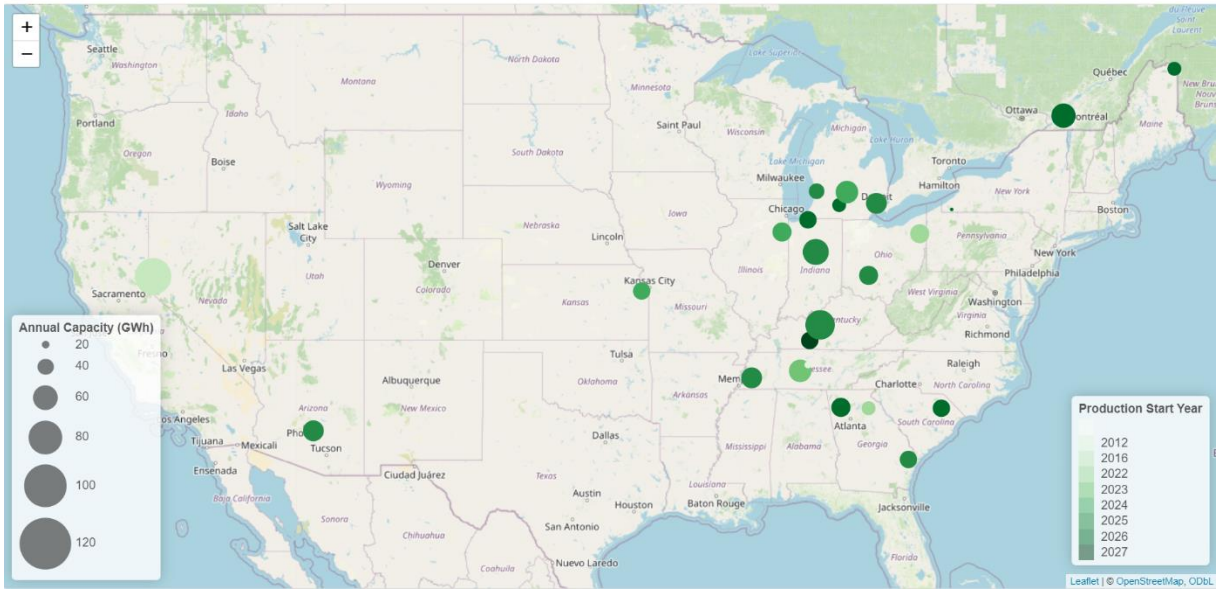
[22] Michelle Lewis, "AESC Is Opening a Huge EV Battery Factory in South Carolina to Supply BMW," Electrek, June 7, 2023, **https://electrek.co/2023/06/07/aesc-ev-battery-factory-south-carolina/**.

[23] White House Briefing Room, "Fact Sheet: CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China," August 9, 2022, **https://www.whitehouse.gov/briefing-room/statements-releases/2022/08/09/fact-sheet-chips-and-science-act-will-lower-costs-create-jobs-strengthen-supply-chains-and-counter-china/**.

[24] Intel, "Innovating and Investing in Ohio," accessed February 19, 2024, **https://www.intel.com/content/www/us/en/corporate-**

base for semiconductors creates a virtuous cycle that encourages more domestic manufacturing of all the products that use those components. The efforts of state governments to secure their share of this manufacturing renaissance, such as Michigan's $500 million addition to the Make It in Michigan Fund, illustrate how much these advanced technology jobs are valued.

Figure 3 Planned US EV Battery Manufacturing Projects



(Source: Guidehouse Insights)

Job Training and Economic Empowerment

Batteries are only one part of the job creation possibilities of electrification. Building up a charging infrastructure will require installers, and those chargers will also require regular maintenance and replacement. The modernization of the grid requires the installation and repair of wind and solar resources as well as behind-the-meter batteries. Deploying and maintaining EV chargers will also require new jobs. At the end of this chain are the mechanics working on EVs and EV batteries. Technology sectors that have been neglected in the US economy can be mobilized to meet these workforce needs—for example, by creating training programs that enable new workers to enter these fields. As trades such as plumbing and electrical work have shown, training programs are essential to providing a steady pipeline of skilled workers. Local colleges, technical centers, and other training locations can serve as hubs for welcoming new workers into EV-related trades and can work to refine their training offerings in collaboration with local governments as well as companies seeking fresh talent. Every stage of this transformation will create different areas of economic opportunity, as well as the potential for new innovations—and innovators—in untapped or underdeveloped markets.

responsibility/intel-in-ohio.html.

Conclusion

The transition to a decarbonized America backed by a thriving economy is well underway but will require decades to complete. Successfully realizing this transition will require the transformation of more than just how America fuels its cars and trucks. The manufacturing industry and its approach to training and attracting talent, as well as the nation's electrical grid, will see changes as well. Stakeholders in all segments of the economy should be working to create this new America and preparing for the opportunities that it brings.

Electrification Is the Next Step

The US is on the edge of a significant change, from an economy powered by fossil fuels to one that is increasingly driven by renewable energy. The government has set ambitious climate targets; by 2030, half of all vehicles sold should be zero emissions vehicles, and 80% of power should come from renewable sources. Transportation is central to these goals because it is one of the easiest segments to decarbonize and it enables the decarbonization of other sectors as well. These seem like enormous changes, but so was bringing electricity to nearly every American home and putting a car in every garage. Transportation electrification is the beginning of a similarly radical shift, one that will bring with it long-term opportunity for economic growth and revitalization.

Benefits from Mobility Electrification

Replacing a gasoline-burning engine with a battery-powered motor offers significant environmental benefits outright. Considering that transportation is responsible for 28% of the carbon emissions in the US, this change alone is massive and necessary. Furthermore, the electrification of mobility and modernization of the grid will revolutionize the industrial power of the US. New manufacturing jobs will appear to create batteries and EVs. New renewable energy generation requires large investments, ongoing maintenance, and new training programs to support the work. Electrification is not just a sustainability goal but an economic engine.

EVs Are Only the Beginning

Outside of transportation benefits, the broader implications of electrified mobility are significant. Needing to charge so many vehicles will require an investment in the electrical grid to meet power demand in a more targeted way. Distributing energy resources opens the door to significant new demand for renewable energy generation. Making the grid cleaner, safer, and more resilient is the only way to ensure that mobility is consistent in a post-gasoline environment. The US is moving to a decarbonized economy, and EVs are only the first step.

Scope of Study

Guidehouse Insights has prepared this white paper, commissioned by the Michigan Economic Development Corporation, to highlight the economic opportunities presented by the growth in EV sales and related high tech manufacturing. It provides a historical perspective on previous transformative shifts brought about through technology; discusses how EVs are creating a manufacturing boom in the US; examines the implications of wider EV adoption in terms of other areas such as vehicle charging and semiconductors; and explores how this will result in job growth and training opportunities.

Sources and Methodology

Guidehouse Insights' industry analysts use a variety of research sources in preparing research reports and white papers. The key component of Guidehouse Insights' analysis is primary research gained from phone and in-person interviews with industry leaders including executives, engineers, and marketing professionals. Analysts are diligent in ensuring that they speak with representatives from every part of the value chain, including but not limited to technology companies, utilities and other service providers, industry associations, government agencies, and the investment community.

Additional analysis includes secondary research conducted by Guidehouse Insights' analysts and its staff of research assistants. Where applicable, all secondary research sources are appropriately cited within this report.

These primary and secondary research sources, combined with the analyst's industry expertise, are synthesized into the qualitative and quantitative analysis presented in Guidehouse Insights' reports. Great care is taken in making sure that all analysis is well supported by facts, but where the facts are unknown and assumptions must be made, analysts document their assumptions and are prepared to explain their methodology, both within the body of a report and in direct conversations with clients.

Guidehouse Insights is a market research group whose goal is to present an objective, unbiased view of market opportunities within its coverage areas. Guidehouse Insights is not beholden to any special interests and is thus able to offer clear, actionable advice to help clients succeed in the industry, unfettered by technology hype, political agendas, or emotional factors that are inherent in cleantech markets.

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