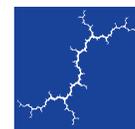




TRANSFORMING TRANSPORTATION IN MICHIGAN

A Roadmap to the State's 2050 Climate Target

Prepared on behalf of
Sierra Club
January 2022



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We would like to thank our external partners for their contributions and review of this report: Charlotte Jameson from Michigan Environmental Council, Charles Griffith from Ecology Center, Douglas Jester from Five Lakes Energy, and Derrell Slaughter from Natural Resources Defense Council.

Cover Images: (top) Picture of bike lane in fall; (bottom left) plugging in car charger; (bottom middle) Detroit Smart Bus—no attribution, Wikimedia CC BY-SA 3.0; (bottom right) Chevy Bolt—Dave Pinter, Flickr (CC BY-NC-ND 2.0).

EXECUTIVE SUMMARY

To address the climate crisis, Michigan has committed to achieving net zero greenhouse gas (GHG) emissions across its economy. As an initial step, the state has begun to set goals for reducing emissions in the electric power sector. The two largest utilities in the state have committed to achieving net zero emissions in the generation of electricity, though much work remains to make these commitments a reality. However, the transportation sector has seen less progress and emissions have been slowly increasing for much of the last decade. With transportation now accounting for 32 percent of Michigan's GHG emissions and contributing to air pollution that harms communities, the state must act quickly to set a pathway for net zero emissions in the transportation sector by 2050.

The slow pace of change in the transportation system requires bold action urgently, before emissions are locked in through mid-century. Although recent commitments have been made by Ford, General Motors, and President Biden to achieve 50 percent electric vehicle (EV) sales by 2030, this report shows that this commitment is not enough for Michigan to reach net zero emissions by 2050. Even when Michigan does achieve increased sales of new EVs, slow fleet turnover means that it could take more than a decade for EVs to comprise a substantial portion of the overall vehicle fleet. Due to the slow pace of vehicle stock turnover, Michigan must phase out new sales of light-duty internal-combustion engine vehicles by 2035 in order for the state to meet its decarbonization goals. The following chapters lay out a set of realistic and achievable policies that, if adopted, ensures Michigan is on track to meet long-term decarbonization goals.

Acting quickly to decarbonize transportation also yields numerous other benefits. As the center of the U.S. auto industry, Michigan has the opportunity to bring the high-tech jobs of the future transportation system into the state. Rapidly shifting to electrification can also reduce the amount of money Michiganders spend on out-of-state oil, while redirecting capital to local renewable energy and saving consumers money that they can spend in the state's economy. Moving toward clean transportation options also improves public health, because burning fossil fuels increases pollutants such as nitrogen oxides, sulfur

dioxide, and particulates that directly cause respiratory and other illnesses. The transformation of the transportation sector provides an unparalleled opportunity to make mobility in Michigan work for everyone, including lower-income households and households without access to private vehicles.

On behalf of the Sierra Club, Synapse Energy Economics, Inc. (Synapse) modeled two scenarios to evaluate the impacts of incremental policies on vehicle electrification and GHG reductions. We analyzed:

- A **Baseline** future, illustrating the likely impacts of today's policies and expected technological progress, and
- A **Clean Transportation** future, in which transportation emissions decline substantially by 2035 through internal-combustion engine vehicle phase-outs and reduced vehicle-miles traveled.

We modeled the public health and economic benefits associated with achieving the *Clean Transportation* scenario and the resulting decline in GHG and co-pollutant emissions. Our analysis has six major findings:

1. **A business-as-usual transportation future is inadequate for meeting Michigan's GHG emissions goals.** Emissions remain high through mid-century in the absence of coordinated policies due to the slow turnover of the vehicle fleet. Maintaining the status quo transportation system also fails to meet the needs of many Michigan residents who are forced to live with air pollution and lack affordable and sustainable transportation options.
2. **Phasing out fossil-fuel-powered passenger vehicles by 2035 puts Michigan on track to reach the state's goal of net zero emissions by 2050.** Every year that emissions remain at current levels increases the damage to the climate and public health. An ambitious 2035 target is also important because the motor vehicle fleet is responsible for the bulk of transportation emissions in Michigan and turns over slowly. Many vehicles remain on the road for more than 15 or 20 years. If vehicle electrification progresses slowly, many fossil-fuel-powered vehicles will still be on the road by 2050.

- 3. Clean transportation offers economic and health benefits.** Leading the transformation of transportation can help keep auto jobs in Michigan. Providing more affordable transportation options and reducing reliance on gasoline saves consumers money that they can spend at Michigan businesses. At the same time, in reducing tailpipe emissions from motor vehicles, it can prevent illness and even premature death for residents suffering from air pollution.
- 4. Clean transportation can and must be equitable.** Michigan's existing transportation system does not serve its residents equitably, in terms of both access to transportation and the impact of transportation pollution. A system built on sprawling highways and fossil-fuel-powered private vehicles is not only unsustainable; it is also too expensive, harmful to public health in already polluted and overburdened communities, and challenging to navigate without access to a private car.
- 5. Fast action is critical.** Substantial changes need to be made to realize a sustainable transportation system. Vehicle manufacturing must be transformed, land use and public transportation must be rethought, and charging infrastructure needs to be deployed on a large scale. These changes will take time, and it is important that the state act quickly to achieve its long-term goals.

In this analysis, the term "EV" includes both full battery electric vehicles (BEVs) and plug-in hybrid vehicles (PHEVs).

- 6. Electrifying motor vehicles is essential.** By 2050, nearly all cars on the road must be EVs. Even with ambitious policies to reduce reliance on private vehicles, there will likely still be many cars and trucks on Michigan's roads by mid-century. These vehicles cannot be powered by fossil fuels if the state is going to meet its net zero emissions goal.

1. MICHIGAN'S CLEAN TRANSPORTATION PROGRESS

Michigan's transportation system is on the verge of a massive transformation. To address the climate crisis, greenhouse gas (GHG) emissions must be reduced dramatically in the coming decades. Today's transportation system pollutes the air in residential neighborhoods across the state and has failed to adequately serve disadvantaged communities. In response, Governor Gretchen Whitmer enacted the *MI Healthy Climate Plan* by signing Executive Order No. 2020-182 and Executive Directive 2020-10, committing Michigan to carbon neutrality by 2050. Michigan can achieve this objective in the transportation sector by

shifting away from fossil-fuel-powered cars and trucks and toward electric vehicles (EV) and alternative transportation modes that reduce reliance on the private car. The choice ahead for Michigan is clear: the state can either accept today's fossil-fuel-centric transportation system or transform the sector so it is cleaner, safer, more affordable, and more convenient for all Michiganders.

Michigan transportation emissions inventory

The transportation sector represents 32 percent of Michigan's GHG emissions. This makes transportation the second largest emitting sector of the economy, just behind the electric power sector (see Figure 1).

Figure 1. Energy-derived CO₂ emissions in Michigan

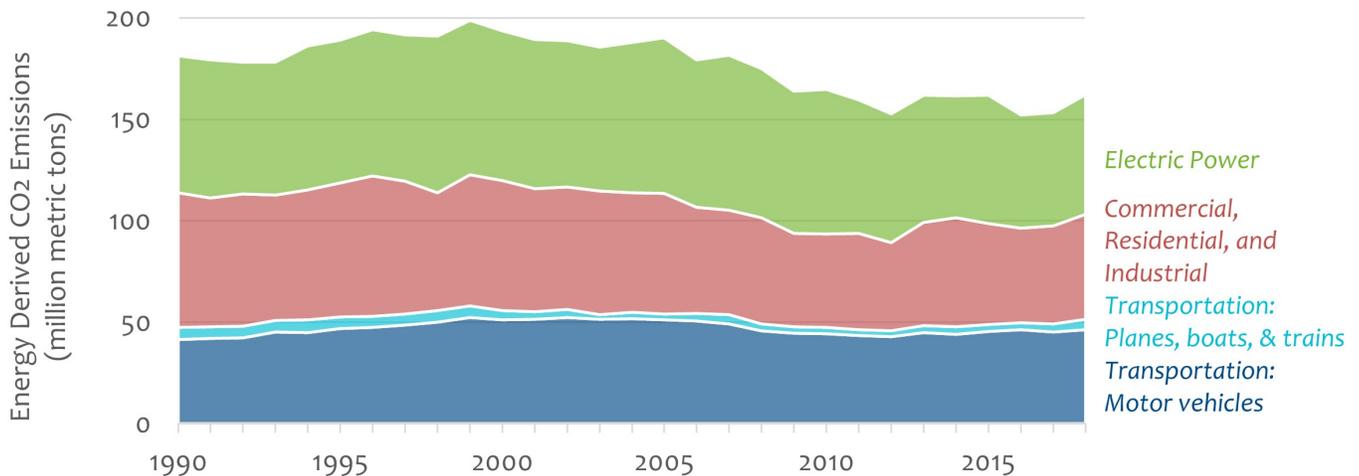
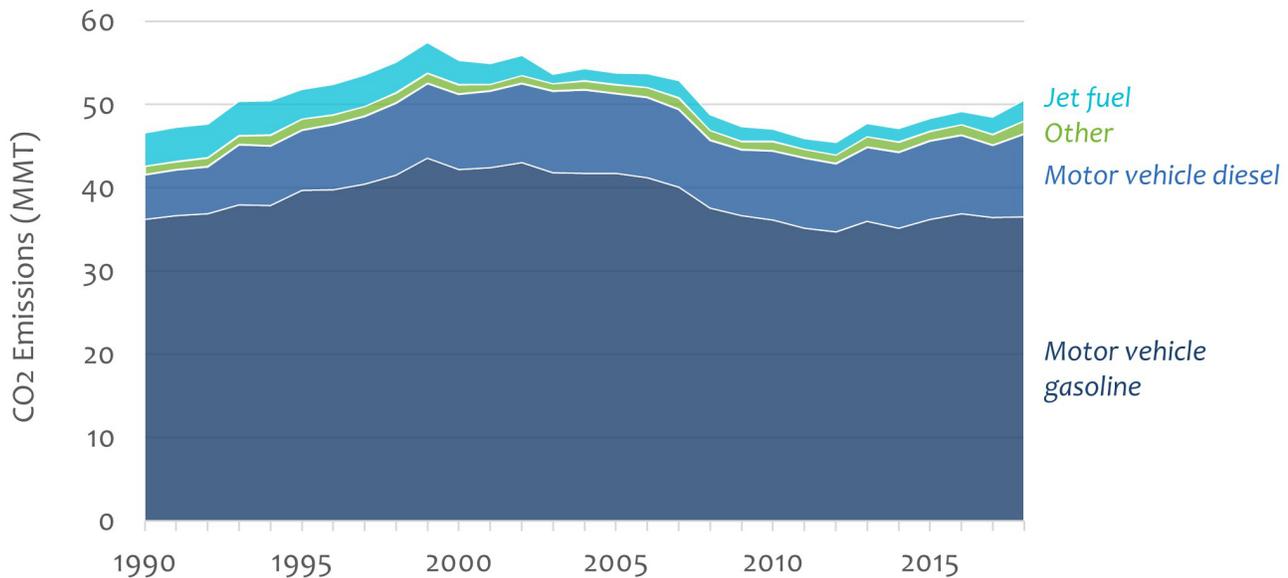


Figure 2 shows the composition of transportation emissions in Michigan as of 2018, the last year for which complete data is available. Today, transportation emissions are primarily due to the consumption of gasoline and diesel in motor vehicles. On-road motor vehicles specifically account for 92 percent of the transportation sector’s total emissions. To meet the state’s GHG emissions reduction targets, motor vehicle emissions will have to drop dramatically in the near term and be completely eliminated by 2050.

Non-motor vehicle emissions are a small fraction of Michigan’s transportation emissions, but the state will

likely need to address these emissions nonetheless. One substantial opportunity is the reduction in emissions from air travel, as jet fuel is the next-largest source of GHG emissions in the transportation sector after motor vehicles. Air travel emissions can be reduced by shifting demand for air travel to electric high-speed rail, increasing the efficiency of airplanes, and developing carbon-neutral synthetic jet fuels.¹ Achieving air travel decarbonization will likely require collaboration with the federal government and other states.

Figure 2. Carbon dioxide emissions from Michigan's transportation sector



Michigan clean energy progress and goals

Michigan has already signaled it intends to address the climate crisis head on. Setting long-term goals is an important first step for the state, as it creates a foundation for future policies aiming to reduce harmful emissions and improve transportation equity and mobility. Both the Governor and the utilities have committed to substantial emissions reductions.

Executive order to be carbon neutral by 2050

On September 23, 2020, Governor Whitmer enacted Executive Directive 2020-10, which sets a goal of achieving statewide carbon neutrality by 2050.² The announcement also sets an intermediate goal of reducing economy-wide emissions 28 percent below 1990 levels by 2025. To achieve these targets, the directive requires the Department of Environment, Great Lakes, and Energy (EGLE) to develop a Healthy Climate Plan, which will serve as a decarbonization roadmap for the state. An accompanying executive order, No. 2020-182, establishes an advisory council that will assist EGLE with developing the plan.³ The proposed policies direct the Michigan Department of Treasury to launch a just transition initiative aimed at supporting communities and workers when fossil fuel facilities retire. They also direct EGLE to develop a comprehensive environmental justice analysis for use by the Michigan Public Service Commission in utilities' integrated resource planning (long-term energy planning).

In February 2020, Governor Whitmer issued an order creating the Michigan Council on Future Mobility and Electrification, which is housed within the Department of Labor and Economic Opportunity and will serve in an advisory capacity to the governor, legislature, and the Office of Future Mobility and Electrification. The Council will develop annual policy recommendations on mobility and electrification and consists of the Directors from seven executive departments and the chairman of the Michigan Public Service Commission, as well as 10 non-governmental members: nine members who represent business, policy, research, or technological leaders in future mobility and one member who represents insurance interests. In its October 2021 report, the Council recommended a range of policy solutions needed to put Michigan at the forefront

of the transition to electrification. These included the following:

- Allocating \$50–55 million to implement a transit and school bus pilot program and a feasibility study; the subject of which will be incentives to enable school districts and transit agencies to purchase electric buses and charging infrastructure, and to access technical assistance and additional resources to help facilitate the electrification of medium- and heavy-duty vehicles.
- Funding to support the development of both public and private EV charging infrastructure with a focus on disadvantaged/underserved communities and legislation requiring utilities to ramp up infrastructure deployment.
- An EV Academy and other incentives to attract and retain a skilled workforce.
- A Global Center of Excellence for Battery Innovation.
- Development of an EV-Ready Community Playbook that local governments can utilize to model local regulations and land-use policies.

Michigan and Four Other Midwest States Create “REV Midwest” Coalition

Governor Whitmer, along with the governors of Illinois, Indiana, Minnesota, and Wisconsin, joined together in signing the Regional Electric Vehicle for the Midwest Memorandum of Understanding (REV Midwest MOU). Collectively the goal of the MOU is to accelerate electrification in the Midwest, specifically around medium- and heavy-duty vehicles. The MOU focuses on joint collaboration around fleet electrification in commercial corridors, advancing equity and emission reductions, creating a charging infrastructure network amongst the region, and ensuring the entire Midwest region is prepared to compete for private investment and public funding for EVs to support economic growth and regional leadership.

Governor Whitmer Launches EV Initiatives

Gov. Gretchen Whitmer announced three new initiatives relating to EVs: creating the nation's first electrified roadway to charge vehicles on the move, the Lake Michigan Electric Vehicle Circuit, and the Michigan Revolution for Electrification of Vehicles Academy/Academies (MIREV). Michigan is testing out the nation's first wireless electrified roadway system that will allow EVs to charge while

driving. This pilot will cover a one-mile stretch of state-operated roadway. The Lake Michigan Electric Vehicle Circuit will place DC fast chargers or level 2 chargers along key Lake Michigan tourism routes connecting communities and state and national parks, and other tourism attractions. The MIREV will train workers for the jobs of the future in this industry and make sure current workers are able to transition to new jobs in electrification, so Michigan is not leaving anyone behind.



Image: DTE EV chargers and scooter at Beacon Park/Lumen Detroit; Mike Berkowitz.

Utility clean energy commitments

Michigan's two largest utilities, Consumers Energy and DTE Energy, have already committed to reducing their carbon emissions, though these commitments are not legally binding. Consumers Energy has committed to net zero emissions by 2040.⁴ Meanwhile, DTE Energy has committed to a 50 percent reduction in carbon emissions by 2028 and net zero carbon emissions by 2050.⁵ The power sector is the largest source of GHG emissions in the state and thus its own decarbonization process will dictate the extent of climate and public health benefits seen from electrifying transportation systems. The transportation sector, which emits nearly as much as the power sector, will require additional clean electricity as it moves away from fossil-fuel-powered vehicles.

Michigan as the center of the U.S. auto industry

Michigan is home to the headquarters of General Motors (GM) and Ford, as well as the North American headquarters of Chrysler, which collectively are known as the big three American automakers. The state is also home to Rivian, a new EV manufacturer that launched an electric sport utility vehicle and pickup truck in 2021. According to the Bureau of Labor Statistics, as of 2019 there were 38,000 motor vehicle manufacturing jobs and 133,000 motor vehicle parts manufacturing jobs in the state. This accounts for roughly 4 percent of all jobs. The Alliance of Automobile Manufacturers, an industry trade group, reports a total of 395,000 auto-related jobs statewide.⁶ Because auto industry employment accounts for an above-average portion of Michigan's economy, the transition toward EVs will impact Michigan even more than other states. To ensure that Michigan continues to be a leader in transportation and auto manufacturing, it will be essential for the industry to move quickly toward zero-emission vehicles and for state lawmakers to promote and support this transition through policy—these vehicles will account for the vast majority of the auto market in the coming decades.

Recently, both GM and Ford have made substantial commitments toward an all-electric future. GM announced a goal of selling entirely zero-emission vehicles by 2035 and becoming an entirely carbon neutral company by 2040. Along the way, the company intends to launch 30 all-electric vehicle models globally by 2025. GM plans to invest \$27 billion in electric (and autonomous) vehicles through 2025 to achieve these goals.⁷ Ford similarly recently announced an investment of \$22 billion in EVs through 2025.⁸ Ford has announced that all of its passenger vehicle sales in Europe will be zero emissions by 2030.⁹

President Joe Biden also announced an executive order—supported by automakers GM, Ford, and Stellantis—with a goal that all new passenger car sales be at least 40–50 percent electric by 2030.¹⁰

2. METHODOLOGY

Synapse performed our analysis using three models: EV-REDI, IMPLAN, and COBRA.

We developed the EV-REDI model in 2018 to analyze vehicle stock turnover and the implications of various policy scenarios.¹¹ It combines a user-specified trajectory of EV sales with state-specific data. The data include total vehicles on the road, vehicle lifetime distributions, vehicle-miles traveled (VMT), fuel efficiencies, and emissions rates. Using this information, EV-REDI calculates and reports estimates of future number of EVs on the road, avoided emissions, increased levels of electricity consumption, and other outputs.

In addition, we used the IMPLAN economic model to evaluate how transportation electrification would impact jobs in Michigan.¹² Complementary sources of data used in this analysis include the Bureau of Labor Statistics for wage information, the National Renewable Energy Laboratory (NREL) for renewable project cost information, and technical reports from the International Council for Clean Transportation (ICCT) and UBS to characterize EV manufacturing impacts.

Finally, we used COBRA, a publicly available model created by the U.S. Environmental Protection Agency (EPA).¹³ COBRA allows users to compare the public health impacts of

two different scenarios. Using our projections of changes in on-road vehicle emissions of particulate matter (PM_{2.5}), nitrogen oxides (NO_x), volatile organic compounds, and sulfur dioxide (SO₂) between the *Baseline* and *Clean Transportation* scenarios, we projected how a cleaner transportation sector can lead to improved public health.

3. MODELING AND RESULTS

We modeled two transportation scenarios for this project. First, we modeled a *Baseline* scenario calibrated to a national EV adoption forecast published by *Bloomberg New Energy Finance* (BNEF) in 2020.¹⁴ This transportation scenario represents a business-as-usual case in which no new policy action is taken. Second, we modeled a *Clean Transportation* scenario that achieves long-term emissions reduction goals through a fossil-fuel-powered passenger vehicle phaseout by 2035 and a reduction in miles traveled per vehicle.

The *Baseline* scenario and *Clean Transportation* scenario model the assumptions described in Table 1. We did not attempt to investigate all potential scenarios or attempt to identify the most likely scenarios. Instead, we identified two representative scenarios that capture the key differences between a business-as-usual transportation system and a more sustainable future transportation system.

Table 1. Scenario descriptions and assumptions

Category	Baseline	Clean Transportation
Description	A business-as-usual future that accounts for current policies and expected future technological progress and cost declines.	A more sustainable transportation future that puts the transportation sector on track to achieve net zero emissions by 2050.
EV market share assumptions	EV market share is based on BNEF's national projections, which reach 24% of all new light-duty vehicle sales in 2030.	We find that to meet Michigan's GHG reduction goals, 88% of new light duty vehicle (LDV) sales must be EVs by 2030, with a total phase-out of new light-duty internal-combustion (ICE) engine vehicle sales by 2035. This aggressive target is necessary considering the slow vehicle turnover rates that keep new fossil fuel-powered vehicles on the road for decades.
VMT Assumptions	VMT per vehicle remains constant in future years.	VMT for light-duty vehicles declines by 7.5% per vehicle by 2035 and 15% by 2050.

Light-duty EV adoption

Figure 3 shows how the EV share of all new light-duty vehicles (LDV) is projected to change through 2050. In the *Baseline* projection, Michigan's EV sales share increases steadily from less than 1 percent of new car sales in 2018 to 48 percent of new car sales in 2035. In subsequent years, the rate of change falls and by 2040 the curve begins to flatten as EV technology matures and price declines slow. In the *Baseline* scenario, EVs constitute 48 percent of new LDV sales in 2035 and 64 percent in 2050. While substantially larger than today, these levels are not enough to reach Michigan's emissions goals.

In the *Clean Transportation* scenario, we modeled a future with both higher levels of EV sales and reduced VMT. The growth in the EV sales share accelerates dramatically beginning in 2021. By 2035, EVs make up 99 percent of all new LDVs sold in Michigan and fully electric BEVs make up more than 82 percent of all new LDVs sold in the state. This aggressive sales trajectory ensures that the state meets its emissions reduction goals for 2050 and is in line with recent commitments made by other states and countries to transition to selling only EVs by 2035 or sooner.

Even if Michigan were to achieve a rapid adoption of EVs in terms of new vehicle purchases, slow fleet turnover means that it will take a long time until EVs comprise a substantial portion of the overall LDV fleet (see Figure 4). In other words, there is a long lag time between when new vehicle sales are predominantly EVs and when the fleet of vehicles on the road is predominantly EVs.

For example, while over one-quarter of all new LDVs sold in 2025 are EVs under the Clean Transportation scenario, EVs represent less than 5 percent of all LDVs on the road in that same year. In that same scenario, EVs are almost 100 percent of sales in 2035 but make up less than 50 percent of all LDVs on the road. This is one of the main reasons why EV sales share must increase so dramatically in the near term for Michigan to achieve its emission reduction goals. In the Clean Transportation scenario, 3.7 million light-duty EVs are on the road in Michigan in 2035, compared to about 26,000 on the road in 2020. By 2050, 93 percent of all LDVs are electric.

Figure 3. EV sales as a percentage of new LDV sales

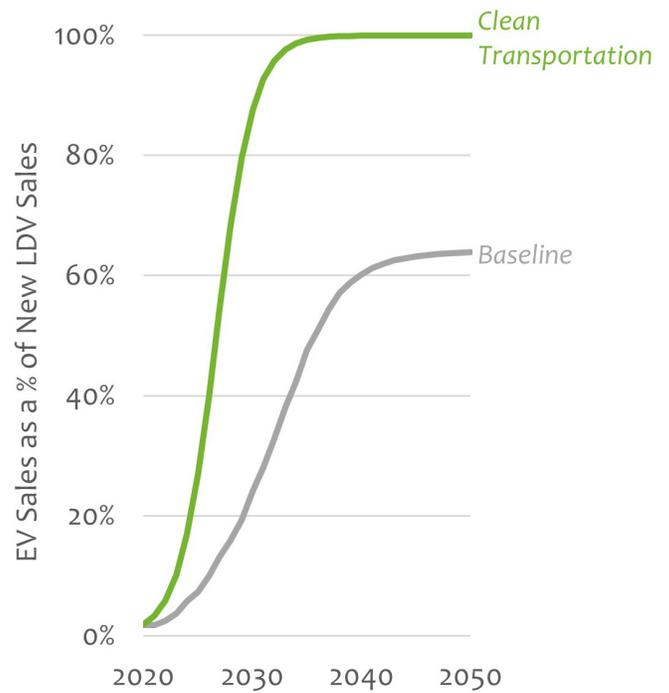
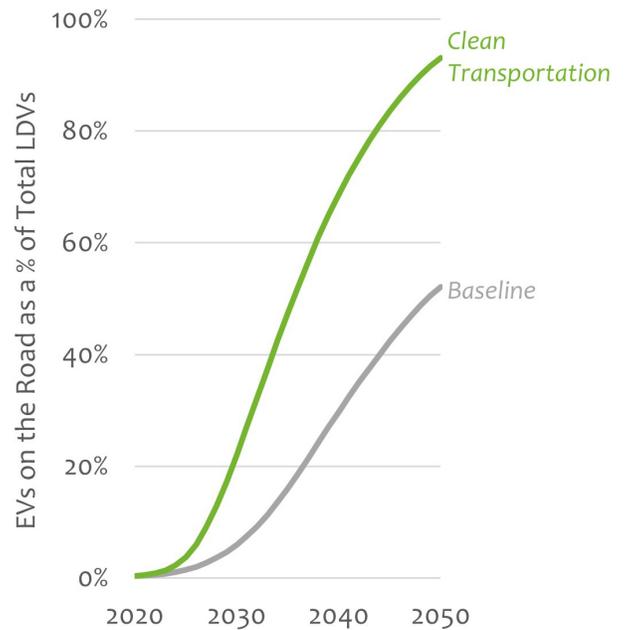


Figure 4. EVs on the road as a percentage of total LDVs



Medium- and heavy-duty EV adoption

We also modeled EV adoption trajectories for medium-duty vehicles (MDV) and heavy-duty vehicles (HDV). Figure 5 and Figure 6 show new EV sales and total EVs on the road in the MDV and HDV segments.

MDVs and HDVs include many different types of vehicles that are likely to have diverse adoption curves. Some types of vehicles (such as transit and school buses) are likely to electrify rapidly while others (such as long-haul freight trucks) are likely to take much longer to electrify. In the *Clean Transportation* scenario, 24 percent of MDVs and HDVs are electric by 2035. This puts the HDV/MDV market share roughly five years behind the LDV adoption pathway. As a result of slower MDV/HDV EV adoption, MDVs and HDVs account for 38 percent of 2035 motor vehicle tailpipe emissions, up from just one-quarter of tailpipe emissions in 2020.



Figure 5. EV sales as a percentage of new MDV/HDV sales

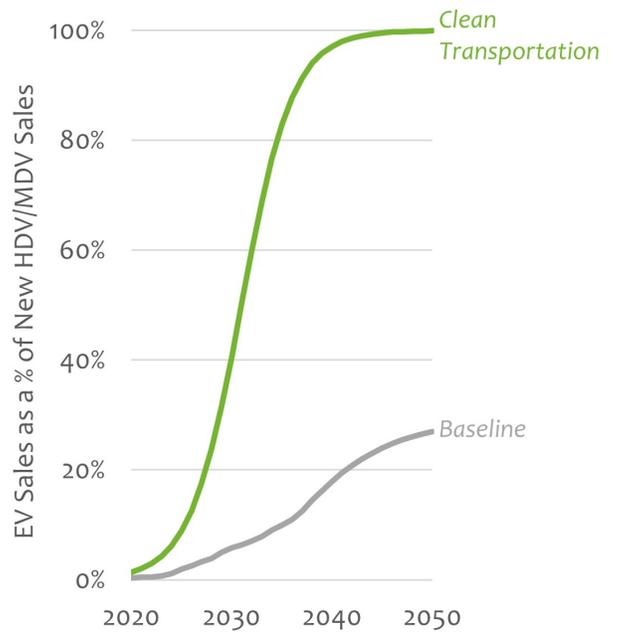
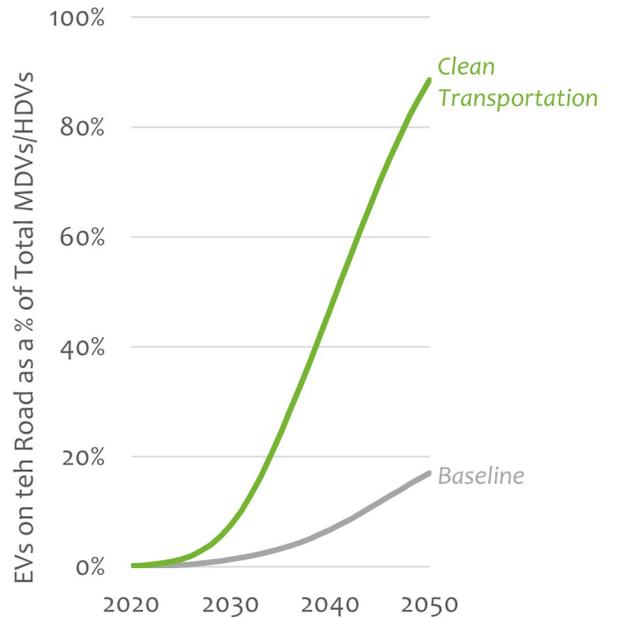


Figure 6. EVs on the road as a percentage of total MDV/HDVs



GHG emissions

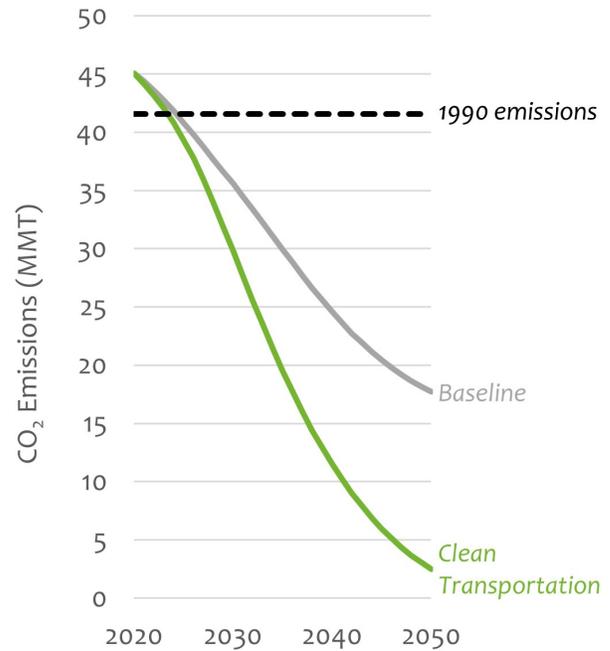
Increasing the number of EVs on the road and decreasing light-duty VMT reduces emissions of GHGs from motor vehicle tailpipes (see Figure 7). Even in the *Baseline* scenario, tailpipe carbon dioxide (CO₂) emissions decline 28 percent by 2035, relative to 1990 levels. This reduction is a result of anticipated improvements and cost reductions in EV technology, improvements in ICE efficiency, and existing policies that drive EV adoption.

The *Clean Transportation* scenario results in much greater emissions reductions, with motor vehicle CO₂ emissions falling by approximately 53 percent in 2035. Further out in the study period, the *Clean Transportation* policy scenario reduces CO₂ emissions from motor vehicle tailpipes by approximately 94 percent by 2050. By comparison, in the *Baseline* scenario, emissions from motor vehicle tailpipes decline by just 57 percent by 2050.

In order to achieve net zero emissions by 2050 economy-wide, motor vehicles will likely need to get as close to zero emissions as possible, given the technological barriers to decarbonizing other sectors.

Using the federal government's estimate for the social cost of carbon (about \$51/metric ton as of 2020) we can quantify the climate damages that could be avoided in the *Clean Transportation* scenario relative to the *Baseline* scenario.¹⁵ Between 2021 and 2050, the cumulative benefit of reduced GHG emissions is \$20 billion. This is a conservative estimate, as many climate scientists and economists believe the social cost of carbon is higher than the federal government's estimate.¹⁶

Figure 7. Motor vehicle CO₂ emissions



Note: This figure includes tailpipe emissions from all motor vehicles, including LDVs, MDVs, HDVs, and buses. It does not include CO₂ emissions that may result from charging.

Electric grid impacts

In each of the two scenarios, EVs are expected to require a substantial amount of electricity, although not necessarily in the near term. For example, in the *Clean Transportation* scenario we project an increase in EV retail electricity consumption from about 0.1 terawatt-hours (TWh) in 2020 to 2 TWh in 2025, 20 TWh in 2035, and 40 TWh in 2050. For comparison, Michigan's total retail electricity consumption in 2019 was about 101 TWh.¹⁷

Michigan can mitigate this load growth significantly by improving energy efficiency and reducing the number of miles traveled in single occupancy vehicles. In addition, considerable EV load can be integrated into today's grid with minimal investments, as has been seen in California.¹⁸ While some grid upgrades may be needed in the longer term as EV adoption grows, the flexible nature of EV load and potential for customer-owned solar generation, storage, demand response programs, and off-peak charging can help utilize electric grid infrastructure more efficiently and cost-effectively. The timescale over which EV load will appear in large quantities also allows plenty of time for utilities to prepare.



Image: Marathon oil refinery complex in Detroit; Mike Berkowitz.

Electric load growth that results from EVs must be met with renewable energy and aggressive efficiency measures to maximize emissions reductions. Importantly, Michigan's largest two utilities have committed to eliminating or significantly reducing power sector emissions by 2050 (Consumers Energy by 2040), and Governor Whit-

mer's *MI Healthy Climate Plan* requires statewide carbon neutrality by 2050. As a result, if Michigan's transportation sector electrifies, the additional demand for electricity from EVs will not result in more electric-sector CO₂ emissions. By charging at flexible hours, EVs can even help integrate renewable energy into the grid and save Michigan residents money.

Public health impacts

As EVs proliferate, they reduce not only CO₂ emissions, but also emissions of other pollutants that are dangerous to human health. The transportation sector is responsible for over half of total national emissions of NO_x, a primary smog precursor.¹⁹ More than 5.2 million Michiganders (52 percent of the state's population) live in counties designated as failing to meet federal health-based ambient air quality standards for smog.²⁰ Seven counties with unhealthy smog levels are in Southeast Michigan and include some of the most economically challenged areas in the state, many majority-Black communities, and large populations of other racial minorities.²¹ Michigan is currently taking steps to prepare its plan to comply with the standards, and the state could include accelerating the transition to EVs as one strategy.

Using Synapse's EV-REDI model, we estimated reductions of criteria pollutants (including sulfur dioxide, nitrogen oxides, particulate matter, and volatile organic compounds) resulting from decreased combustion of gasoline and diesel. Exposure to these pollutants results in increased asthma rates, respiratory illnesses, cardiovascular ailments, lost work-days, and premature death. According to the *2019 Michigan Asthma Atlas* from Michigan Department of Health and Human Services, in 2016 Michigan had the sixth highest prevalence rate (10.9 percent) of current asthma among adults compared to other U.S. states.²²

Using EPA's COBRA model, we can estimate avoided health incidences and associated monetized benefits. We estimate that by 2035 the increased number of EVs and the reduction in VMT in the *Clean Transportation* scenario (relative to the *Baseline*) will cumulatively avoid 75 premature deaths and 4,600 work loss days, and will result in monetized benefits of \$860 million (see Table 2). Further

Table 2. Cumulative statewide health benefits, relative to the Baseline scenario

	Clean Transportation					
	Through 2035			Through 2050		
	LDV	MDV/HDV	Total	LDV	MDV/HDV	Total
Monetized Health Impacts	\$520M	\$340M	\$860M	\$2,600M	\$3,300M	\$5,900M
Avoided lost workdays	2,800	1,800	4,600	14,000	18,000	31,000
Avoided premature deaths	45	30	75	230	290	510

out, we project these benefits to increase to 510 avoided deaths, 31,000 avoided work loss days, and \$5.9 billion by 2050. Due to differences in EV adoption trajectories between vehicle types, health impacts of MDV/HDV adoption tend to be realized later than those of LDV adoption. In 2035, MDVs and HDVs account for just 39 percent of cumulative monetized health impacts, but by 2050 their share of monetized benefits increases to 56 percent. This only includes health benefits linked to reductions in air pollution—it does not include reductions in deaths and injuries related to motor vehicle collisions.

In addition, the numbers described here only quantify the public health benefits achieved as a result of the decreased emissions in the Clean Transportation scenario relative to the Baseline scenario. In all scenarios, we observe a large amount of pollutant reductions caused by older, dirty vehicles coming off the road. As these vehicles are retired in favor of newer, cleaner vehicles (EVs or otherwise), pollution comprising sulfur dioxide, nitrogen oxides, and particulate matter will decline.

Equity impacts at the county level

Health impacts associated with motor vehicle use are not equally distributed. According to the 2019 Michigan Asthma Atlas, asthma prevalence is 14.4 percent among adults with less than \$35,000 in annual income.²³ This is significantly higher than the rates experienced by adults in higher income brackets, which fall between 9.3 percent and 8.3 percent. There are also racial disparities in asthma

prevalence. Black adults experience asthma prevalence at a rate of 14.7 percent, compared to only 10.1 percent among white adults. Reducing emissions from motor vehicles—through VMT reductions and electrification—will benefit all communities, but policymakers must be cognizant of how benefits are distributed throughout the state.



Image: Playground and River Rouge coal plant; Mike Berkowitz.

EVs and alternative modes of transportation can help reduce the disparities in health outcomes for the state’s low-income communities and communities of color, especially given that Michigan’s smog problem is centered in such communities. The *Clean Transportation* scenario yields the highest per-capita health benefits in the three largest Detroit-area counties (Wayne, Oakland, and Macomb), all of which are above 20 percent non-white (see Figure 8). In fact, Detroit’s Wayne county, which has the

highest share of non-white residents and the third-highest poverty rate in the state, enjoys the highest per-capita health benefits in the *Clean Transportation* scenario. The greatest per capita public health benefits of clean transportation are realized in the counties with the largest non-white populations.

In practice, achieving equitable health outcomes will also depend on the distribution of EV adoption. Policymakers should prioritize solutions that promote EV accessibility in historically disadvantaged communities to ensure that benefits from the state’s decarbonization initiatives flow towards those who need them the most.

Figure 8. Per-capita health benefits by county in the Clean Transportation scenario



Note: Bubble area is proportional to county population.

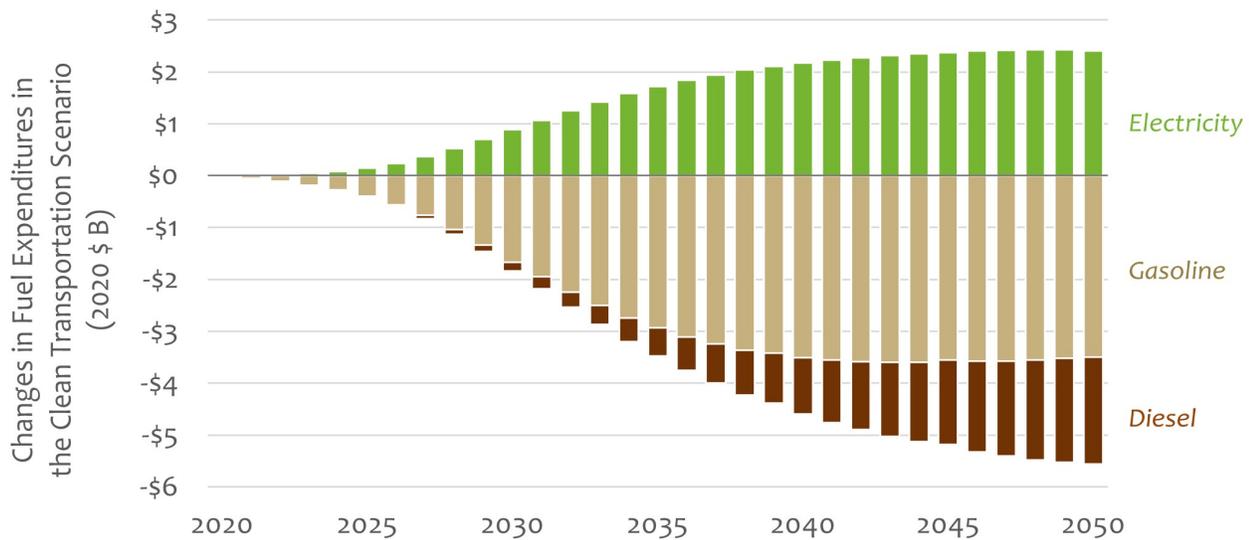
Avoided fuel costs

Another benefit of the *Clean Transportation* scenario relative to the *Baseline* scenario is that consumers save money on fuel. In the *Clean Transportation* scenario, EVs account for a larger share of all VMT as well as total VMT reductions. These two factors reduce costs for households and businesses. EVs are far more efficient than gasoline vehicles, so the cost of electricity to power an EV is lower than the cost of gasoline to fuel a conventional vehicle. Thus, accelerating EV adoption saves consumers money on fuel costs. Meanwhile, reducing VMT brings down the total amount of fuel that consumers need to purchase. The combined effect of these factors is shown in Figure 9.

In total, we project that \$94 billion in fossil fuel expenditures will be avoided in the *Clean Transportation* scenario, relative to the *Baseline* scenario. Although spending on electricity will increase over time, Michigan will still see fuel savings because EVs are much more efficient vehicles overall; cumulative fuel savings between 2021 and 2050 are projected to approach \$51 billion.

Some Michigan households might also decide to keep fewer vehicles in the *Clean Transportation* scenario due to the increased availability of alternative transportation modes. These households would see even greater savings by eliminating the high costs of vehicle ownership, maintenance, and insurance; but these savings are not quantified here.

Figure 9. Annual fuel expenditures in the *Clean Transportation* scenario relative to the *Baseline* scenario



Economic impacts

Net economic impacts from the *Clean Transportation* scenario are expected to be modestly positive. Reduced spending on auto maintenance and gasoline may lead to reductions in jobs. Meanwhile, increased spending on EV purchasing and EV charging infrastructure, as well as the positive effect of transportation electrification on re-spending owing to its cost-effectiveness, produces net positive gains in jobs and income. Notably, the shift away from traditional vehicle manufacturing to EV manufacturing is expected to have only a modest impact on the over-

all statewide economy in spite of Michigan’s historical stature as a base of automobile manufacturing. While some jobs that are currently structured around the manufacturing of ICE vehicles will not remain in their exact same form, we project a net increase in jobs as a result of electrifying Michigan’s transportation sector. Workforce transition and training programs will be crucial to realizing the potential benefits for Michigan’s workers.

Table 3 presents average annual changes in jobs-years and income.²⁴ See this document’s Appendix for more detail on these categories.

Table 3. Average annual change in job-years and income associated with each of the modeled effect

	Average Annual Change in Jobs-Years	Average Annual Change in Income
Auto Manufacturing	-50	370
EV Charging Infrastructure	7,860	4,990
Auto Maintenance	-10,090	-6,840
Fuel Switching	-5,220	-2,490
Grid Investments	5,860	2,560
Respending	9,440	3,300
Total	7,790	1,890

Note: All values have been rounded to the nearest ten.

Figure 10 and Figure 11 present annual jobs and annual income impacts from the *Clean Transportation* scenario. The jobs and income effects mirror each other, with responding, grid investments, and spending on charging infrastructure driving the overall positive impacts. As noted above, changes in automobile manufacturing yield a limited influence on the jobs and income results.

Figure 10. Annual change in employment resulting from Clean Transportation scenario

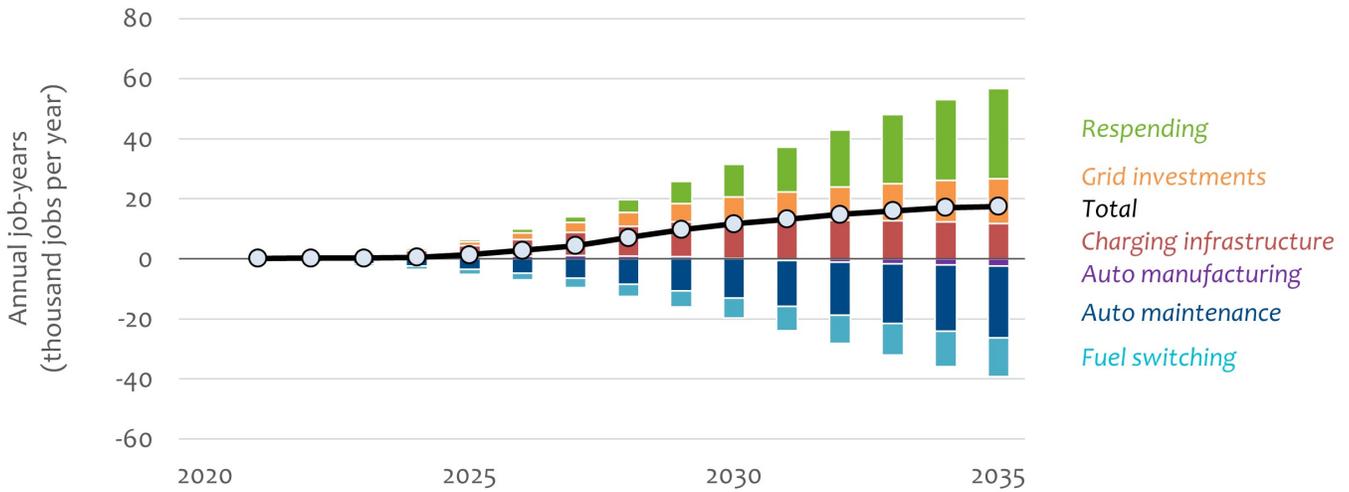
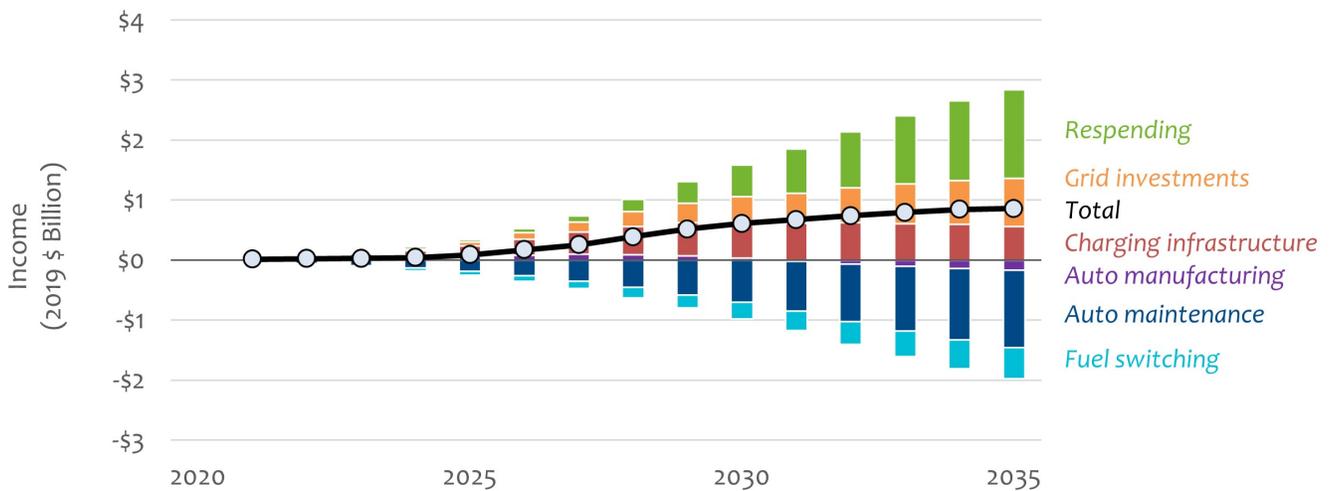


Figure 11. Annual change in income resulting from Clean Transportation scenario



4. ACHIEVING AN EQUITABLE CLEAN TRANSPORTATION FUTURE

Governor Whitmer’s administration has committed to a just transition to a net zero emissions economy. The Department of the Treasury has been tasked with launching an Energy Transition Impact Project (ETIP) to better understand where specific jobs and local tax revenues may be at risk and to explore opportunities to mitigate disruptions to the impacted communities. The state has also begun to consider whether utility integrated resource plans (plans for long-term electricity supply) are consistent with emissions reduction goals and environmental justice objectives in particular.²⁵ These and other environmental equity and justice efforts will be guided by the state’s Climate Justice Brain Trust. This group of experts will identify barriers to environmental justice communities realizing the benefits of the clean energy transition, and it will guide policy development to ensure equitable outcomes from the *MI Healthy Climate Plan*.²⁶

As the transportation sector decarbonizes, principles of equity and justice will again need to guide the transition. While EVs have a large role to play in decarbonizing the transportation sector, Michigan will have to think more broadly to make the transportation system work for all residents. Frontline communities have borne the brunt of the harmful impacts of the fossil-fuel-intensive transportation system of the past. This system has built highways through low-income communities and communities of color, ruined air quality in densely populated neighborhoods, and failed to provide adequate mobility to disadvantaged communities. Michigan can begin correcting the mistakes of the past by addressing two urgent problems with its historical transportation systems: air pollution from fossil-fuel-powered transportation in low-income communities and communities of color, and inequitable access to mobility—including clean transportation options.

Reducing criteria pollutants in environmental justice communities

Fossil-fuel-powered cars and trucks emit many pollutants, including particulate matter, nitrogen oxides, and sulfur dioxide that directly impact human health. These pollutants cause cardiac and respiratory diseases, among other illnesses.²⁷ As described above, moving toward a clean transportation future can reduce monetized public health impacts by nearly \$6 billion through 2050. Importantly, these health impacts are not uniformly distributed. Low-income communities and communities of color face the worst air quality as a result of inequitable transportation systems, as well as other sources of pollution.

In our analysis, we found that counties with higher shares of non-white residents tended to experience the greatest public health impacts per capita when modeling the *Clean Transportation* scenario. This matches analysis done by others. For example, a 2019 analysis by the Union of Concerned Scientists titled *Inequitable Exposure to Air Pollution from Vehicles* found that Latino, Asian-American, and Black residents in the Northeast and Mid-Atlantic are disproportionately burdened by air pollution from vehicles; respectively, these populations face 75 percent, 73 percent, and 61 percent higher exposure to particulates compared to white communities in the Northeast and Mid-Atlantic.”²⁸



Image: Rosa Parks Transit Center in Detroit; Mike Berkowitz.

Additional disparities that exist at smaller scales than the county level were not quantified, but these are also important. Major transportation corridors often run through densely populated urban neighborhoods, such as the 48217 zip code in southwest Detroit. This is Michigan’s most intense air pollution and environmental injustice hotspot. The neighborhood is surrounded by three busy highways that generate emissions from motor vehicles, in addition to one coal-fired and one gas-fired power plant, an oil refinery, a steel mill, and a wastewater treatment plant. Freight hubs are also often located near disadvantaged communities. A clean transportation future must prioritize cleaning the air in these neighborhoods immediately.

Providing access to affordable, clean transportation for all

The second major obstacle to transportation equity is the disparity in the level of service that the transportation system provides to different communities. Today’s transportation system in Michigan is heavily dependent on private vehicles. The *Michigan Travel Counts III* study found that, as of 2016, 88 percent of all trips in the state were made using private vehicles.²⁹ While many households may be able to afford the costs of vehicle ownership, transportation costs are a large burden for low-income households. In 2018–2019, Detroit area households spent an average of \$11,260 on transportation, 94 percent of which went toward purchasing and operating private vehicles.³⁰ An auto-centric transportation system leaves low- and moderate-income residents stuck choosing to either pay the high costs of vehicle ownership or go without access to important destinations. Providing access to more affordable transportation modes such as public transportation, walking, and biking should be a key goal for the future clean transportation system.



Image: A protected bicycle lane in Ann Arbor; Mike Berkowitz.

Facilitating the transition to a clean transportation workforce

As Michigan embraces a clean transportation future, it must be careful to avoid leaving behind any of the workers who have put Michigan at the forefront of the U.S. auto industry. In our analysis, we found transitioning to a more sustainable transportation future would lead to a net increase in jobs in the state. Indeed, there are opportunities to create high-paying jobs building the infrastructure that will be needed to support EVs, as well as public transit and active transportation modes. In addition, the savings on fuel achieved by adopting cleaner transportation options will allow Michiganders to spend more money in state, benefiting the state’s broader economy. However, some specific jobs may not exist in their same form as fewer ICE vehicles are manufactured. The state will need to support the transition of workers in these positions to new opportunities in the clean transportation industry.

5. POLICY TAKEAWAYS AND RECOMMENDATIONS

To achieve net zero emissions by 2050, Michigan needs to act now. Replacing fossil-fuel-powered vehicles with EVs and reducing VMT are the two major levers the state can use, given the large portion of transportation emissions coming from on-road vehicles. The state should take near-term action to set electrification in motion while looking ahead to the more ambitious policies required to make progress on both fronts.

Baseline transportation-sector GHG reductions are inadequate

Although transportation-sector emissions are projected to decline between now and 2035, absent additional policies, the rate of decline will be insufficient for Michigan to meet its long-term climate obligations. In the Baseline scenario, we find that GHG emissions from Michigan's motor vehicles are projected to be 57 percent below 1990 levels by 2050. This is far short of the net zero emissions needed to avoid catastrophic climate change. Michigan will need ambitious new policies to meet its clean transportation goals, and to realize a safe climate and equitable transportation system for all Michiganders.

A phase-out of new light-duty ICE vehicles by 2035 is achievable and puts Michigan on track to meet its long-term climate goals

A phase-out of new light-duty ICE vehicle sales by 2035 is both achievable and ambitious. More than half of cars and light trucks in the United States remain on the road for longer than 15 years, which means that vehicles sold in the next several years could lock in GHG emissions far into the future. A 2035 phase-out gives the vehicle fleet the time it needs to turn over by 2050 and be replaced with zero emissions vehicles. This target puts the state on track to achieve net zero emissions in 2050, as demonstrated by our modeling. The *Clean Transportation* scenario modeled here results in an on-road emissions reduction of 94 percent by 2050, before accounting for early replacement or scrappage programs for ICE vehicles that could be implemented in the 2040s.

Setting a 2035 phase-out for new ICE vehicles will ensure that Michigan stays on track to meet its mid-century goal. The technologies and policies needed to get there are already available. Each year, automakers launch increasingly competitive EV models that can get drivers where they need to go cost-effectively and conveniently while providing superior driving performance and comfort.

Cleaning up the transportation sector will produce public health and economic benefits

Our analysis finds that following the roadmap in the *Clean Transportation* scenario will avoid 75 premature deaths and 4,600 lost work-days, and it will also result in monetized benefits of \$860 million by 2035 relative to the *Baseline* scenario. Farther out, we project these benefits to increase to 510 avoided deaths, 31,000 avoided lost work-days, and \$5.9 billion by 2050.

Cleaner transportation also means less money leaving the state to pay for fossil fuels, and more money left in-state for Michiganders. Through reduced VMT and the proliferation of EVs, we project that \$94 billion in fossil fuel expenditures will be avoided in the *Clean Transportation* scenario, relative to the *Baseline* scenario. Net of increased electricity expenditures, we observe cumulative fuel savings of \$51 billion.

We also expect modestly positive economic impacts resulting from following the *Clean Transportation* scenario. Increased spending on EV purchasing and charging infrastructure, in addition to the positive effect of cost-saving transportation electrification on respending, produces net positive gains in jobs and income. Reduced spending on auto maintenance and gasoline may lead to reductions in jobs.

While some jobs that are currently structured around the manufacturing of ICE vehicles will not remain in their exact same form, we project a net increase in jobs as a result of electrifying Michigan's transportation sector. Workforce transition and training programs will be crucial to realizing the potential benefits for Michigan's workers.

Investment in public transportation

Public transportation is an important alternative to private vehicle trips, especially in urban and densely populated neighborhoods. Public transit includes rail (e.g., trains, subways, and streetcars), bus rapid transit, local bus service, and other modes. These transportation modes provide access to destinations throughout a city, town, or metropolitan area. Public transportation is more equitable because it requires no upfront investment by the rider in vehicle ownership and fares can be kept low to incentivize use. Further, public transportation is more energy efficient than private vehicles because it can move large groups of people using smaller numbers of buses or trains. Mass transportation can also easily run on low-carbon energy resources; rail transit systems are usually powered by electricity and buses owned by public authorities can be electrified at a faster pace than private vehicles.

Prior to the COVID-19 pandemic, several city and county leaders in southeast Michigan were planning to launch a regional transit system, and if that effort resumes it could offer substantially more affordable transportation options to residents of the Detroit metro area. Other regions of the state can also invest in public transit systems to alleviate traffic congestion and provide more transportation options to residents. These regions can also prioritize bus electrification to ensure cleaner air quality and fewer GHG emissions.

The state should allow regions more flexibility for funding local transit investments to help make improved transit a reality. Allowing local jurisdictions to use sales tax adders and other mechanisms to raise needed revenue can provide communities across the state the options they need to fund high quality transit.

Michigan could also invest in public transportation that connects communities across the state. Rail service, such as the proposed Ann Arbor to Traverse City Passenger Rail, can create new economic opportunities for Michigan's larger and smaller municipalities while improving access to sustainable transportation options.

Clean transportation policies must be equitable

While EVs will play a central role in the reduction of GHG emissions in the transportation sector, Michigan must also pursue policies that promote equity and environmental justice to realize a truly sustainable transportation system. Historically, frontline communities have borne the brunt of the harmful impacts of the fossil-fuel-intensive transportation system. These communities have been damaged by highways built through communities, toxic air quality, and poor public transportation infrastructure.

Walking infrastructure, biking infrastructure, and shared-use vehicles

Walking and biking are among the most affordable and energy efficient modes of transportation and should be encouraged as part of a clean energy future. These modes of transportation also have additional health benefits and can improve quality of life relative to reliance on driving and being stuck in traffic. Walking and biking can be promoted by providing spacious and well-maintained sidewalks, protected bike lanes, bike parking, and intersection designs that prioritize the safety and comfort of pedestrians and cyclists. These interventions importantly also reduce pedestrian and cyclist injuries on the road. As described in the next section, active transportation modes can also benefit from smart land-use policies that allow for mixed-use neighborhoods with ample housing and amenities.

For single-occupancy-vehicle trips that are difficult to replace with public transportation or other means, shared-use vehicles provide another alternative. One 2020 meta-study of lifecycle GHG emissions from shared-use vehicles in the Netherlands, San Francisco, and Calgary found that these vehicles may reduce lifecycle GHG emissions by 3 to 18 percent, relative to emissions from typical mobility (including cars, trains, and bikes, after accounting for rebound effects).³¹ Emissions saved from shared EVs relative to gasoline-powered single-occupancy-vehicle use would be even higher.

Prioritizing clean transportation investments in frontline communities

Exposure to particulate matter often increases asthma rates, respiratory ailments, cardiovascular issues, and even premature death. Other studies have found that children, and in particular poor children, bear the brunt of diseases linked to burning fossil fuels.³² Low-income Michiganders and communities of color are disproportionately likely to be exposed to these pollutants as a result of living in close proximity to major transit corridors such as congested highways, trucking roads, and bus routes. By focusing on the electrification of vehicles using these roads (such as short-haul trucks and transit buses), Michigan can prioritize reducing criteria pollutant emissions in areas where they have been historically prevalent.

Incentivizing sustainable transportation modes

To ensure that Michigan meets its climate goals, access to more sustainable transportation modes should go hand-in-hand with policies to promote the use of these cleaner alternatives. Mechanisms to encourage active walking, biking, or public transportation over driving include VMT fees and roadway changes that prioritize sustainable modes of transportation over private vehicles. These types of policies work best after safe and affordable alternative transportation modes become available so that drivers have better options.

Transportation infrastructure funding can also shift priorities between more and less sustainable transportation modes. Michigan should limit roadway expansions and instead opt to invest in other transportation options to increase access to walking, biking, and public transit. Funds that do go toward roads should be focused on maintaining a good state of repair and ensuring that streets are safe and convenient for all users, including pedestrians and cyclists.

A transition to a clean transportation future can begin to remedy some of these inequities by reducing pollution and cleaning up dirty transportation corridors. Further, by reducing the focus on single-occupancy vehicles and increasing funding for other types of transportation, Michigan can reduce the burdensome costs of transportation on low- and middle-income residents.

Finally, clean transportation policies must support Michigan's auto workers in order to be equitable. Michigan should embrace workforce transition and training programs to ensure that workers possess the necessary skills to power a clean transportation transition.

Quick action is critical to putting the state on a trajectory to reduce emissions

Michigan must act rapidly to realize its clean transportation goals and the benefits they can bring. Smart growth policies and public transit investment opportunities like the ones described in the previous section are widely documented and can begin to reduce reliance on personal vehicles in the near term. Michigan also needs ambitious policies on electrification imminently to be on track to reach its 2050 decarbonization goal due to long vehicle lifetimes and low fleet-turnover rates. To reduce transportation emissions and meet its long-term climate goals, Michigan has to implement policies that will quickly increase the share of new vehicle purchases that are EVs.

The state has already taken some promising first steps toward a more sustainable transportation future. Governor Whitmer's 2022–2023 Executive Budget recommendation for the Mobility Futures Initiative would “invest \$25 million in the rapidly evolving industries, infrastructure, and workforce opportunities available in the mobility sphere to position Michigan as a global leader in mobility and electrification.” The initiative provides funding to bring new electrified transportation technologies and pilot projects to Michigan. It also supports the development of a clean transportation workforce. The goal of this initiative is to make it easier for residents and businesses to switch to EVs and improve equitable access to public transportation.³³ Funding these types of programs is an important step toward maximizing the benefits of the ongoing transformation of the transportation system to Michigan's residents and workers.



Michigan can quickly build on this progress by expanding funding for these initiatives, as well as implementing public fleet commitments and investing in charging infrastructure.

Public fleet commitments

One area where Michigan can lead the way with EV adoption is by procuring EVs for public fleets. Purchasing EVs for public fleets now can increase EV demand while market adoption is still limited. It can also increase public familiarity with the technology. As the Institute for Energy Innovation suggests, the state should aim to procure at least 50 percent light-duty EVs by 2023 and 100 percent light-duty EVs by 2025 at the latest.³⁴ The earlier the state accelerates EV procurement, the greater the effect the policy will have. Public fleets account for a relatively small fraction of the total vehicles in the state, so additional policies will be needed to achieve widespread EV adoption.

Michigan can also take advantage of funding available through the Volkswagen settlement to accelerate the electrification of targeted fleets for which EVs are already commercially available. By prioritizing funding toward vehicle electrification, technologies that can support immediate emissions reductions, and charging infrastructure deployment, the state can maximize the impact of the available funding in accelerating the transition to clean vehicles. The state should frequently evaluate the use of the funds to ensure that incentives continue to be appropriately sized as EV prices decline.³⁵

One example of fleets that should be electrified quickly is transit bus fleets. Electric transit buses are among the fastest growing segments in the transit industry, with many bus manufacturers now selling buses powered by electricity alone (e.g., Proterra, BYD, New Flyer). With the right incentives or financing programs in place, electric transit buses can also provide substantial savings from lower fueling and maintenance costs.³⁶ Replacing diesel buses is also an important way to reduce criteria pollutant emissions in densely populated urban communities.

Smart growth and land-use policy conducive to sustainable transportation modes

Smart growth and improved land-use planning can enable more sustainable transportation modes. Allowing for construction of multifamily residences near transit hubs, in addition to pedestrian-friendly neighborhoods with key amenities, can offer residents more convenient access to grocery stores, jobs, healthcare, and stores and restaurants. Smart neighborhood design also reduces reliance on expensive private vehicles and reduces the amount of time and energy it takes for people to reach their destinations. These interventions can also boost the local economies of neighborhood and town centers by increasing the number of people who live nearby and pass through on foot. Michigan can support smart growth by investing in neighborhood and town centers and by incentivizing zoning reform that allows for vibrant mixed-use neighborhoods. These measures can in turn support walking, biking, and public transportation.

Care should be taken to ensure that policies targeting land use and public transportation are designed with an equity lens. While expanded mass transit, improved pedestrian and cycling infrastructure, and transit-oriented development reduce CO₂ emissions and improve livability, without safeguards they may gentrify communities and displace lower-income residents. As policies are deployed to encourage low-carbon transportation, policymakers may also need to implement parallel policies for affordable housing and rent stabilization to ensure access to livable communities.

Charging infrastructure deployment

Charging infrastructure is essential for enabling widespread adoption of EVs. The state should work to ensure that charging is readily available at people's homes, including multifamily buildings, at workplaces, and in key public locations across the state like highway corridors.

In order to support rapid adoption of EVs, Michigan should continue to use its Volkswagen Settlement funds to support development of a fast-charging network across the state. Michigan has been allocated about \$65 million in Volkswagen Settlement funding. Up to 15 percent of this funding can be directed toward EV charging infrastructure.³⁷ Michigan has allocated \$10.5 million to date, with only a small fraction expended on infrastructure.³⁸

The state should also seek additional sources of funds to expand its charging network as the number of EVs in the state continues to grow. Utilities can play a role in the expansion of charging infrastructure; facilitating the transition to EVs will help increase the utilization of electric grid infrastructure, with the ability to lower rates for all electric customers. Consumers Energy's PowerMIDrive pilot program, for example, offers rebates for charging station deployment in key locations.³⁹

Expanding these pilot programs can accelerate EV adoption, and the state should consider expanding utility support for EV charging with durable, full-scale programs in order to prepare for widespread electrification. The Michigan Public Service Commission recently directed Consumers Energy to develop a robust "permanent program" offering to support its territory-wide EV adoption goals.⁴⁰ Such a program could provide basic utility-side infrastructure support with targeted customer-side incentives that address critical market needs, improve access to clean transportation options for low- and moderate-income customers, and reduce transportation pollution in overburdened communities.

Utilities can also contribute to the growth of the EV market by developing rate structures that meet the needs of EV charging customers and offer lower-cost electricity in off-peak hours.⁴¹



Image: EV chargers at Beacon Park with DTE headquarters in the background; Mike Berkowitz.

Michigan can further accelerate the deployment of EV charging infrastructure by incorporating requirements for chargers in building codes that govern new construction. This can ensure that new buildings are future-proofed for an all-electric future.

Types of EV charging infrastructure

Most charging is expected to occur at home. According to the U.S. Department of Energy, home charging accounts for more than 80 percent of the total.⁴² Therefore, it is important to make sure that all Michigan residents who need to rely on private vehicles have access to charging at home. This includes those who live in multifamily buildings or who do not have access to off-street parking. Home charging infrastructure should also be made affordable for low- and middle-income households as installation can be a considerable investment.

As maximum EV charging speeds increase with improved battery technology, Michigan should also prioritize developing a network of DC fast-chargers that provide quick charges and facilitate longer trips. New DC fast-charging stations can charge vehicles at 150 to 350 kW, which at a vehicle efficiency of three miles per kWh can provide 150 to 350 miles of range in 20 minutes. Many EV models today can already charge at rates close to or exceeding 150 kW.

Michigan's 2050 goal will require ambitious efforts to electrify

EVs have a large role to play in the reduction of harmful emissions from the transportation sector. Even as more alternative modes of transportation are made available to reduce dependency on private vehicles, cars and trucks will likely continue to account for a significant portion of the energy consumed by the sector through 2050.

Due to the long lifetime of both light- and heavy-duty vehicles, the state will need to minimize the number of new polluting vehicles put on the road as quickly as possible. Some vehicles built in 2030 and many built in 2035 will continue to operate through 2050, so it is important that most of these vehicles be EVs in order for Michigan to achieve its long-term climate goals. This provides a clear timeline, as demonstrated by our modeling of a *Clean Transportation* scenario, to transition the new vehicle market to EVs and to enable the state to achieve net zero emissions by 2050.

To achieve the amount of electrification needed, Michigan must consider adopting strong policies supporting the uptake of clean vehicles, such as Clean Car and Truck programs, EV incentives, and pollution fees.

Clean car and truck programs

Clean car and truck programs such as fuel efficiency and zero emissions vehicle (ZEV) standards provide the strongest regulatory tools for reducing emissions from new vehicles. These types of standards require auto manufacturers to produce vehicles that achieve a minimum required fleet average fuel efficiency. The federal government is responsible for setting fuel efficiency and GHG standards (called Corporate Average Fuel Economy, or CAFE standards).

The federal *Clean Air Act* also allows the state of California to optionally set its own more aggressive fuel efficiency standards. Other states are permitted to follow either the federal or California standards. California has recently indicated it will require all new light-duty vehicles sold in the state to be ZEVs starting in 2035.⁴³ Michigan does not currently follow the California ZEV standard. Similar standards exist for medium- and heavy-duty vehicles. California's Advanced Clean Truck rule requires truck manufacturers to offer and sell increasing numbers of zero emissions trucks. This rule offers Michigan an opportunity to decrease GHG emissions as well as harmful criteria pollutant emissions that disproportionately affect disadvantaged communities.

Emissions standards are effective because they set clear trajectories for both emissions reductions and automaker manufacturing plans. These policies require automakers to produce environmentally safe products instead of putting the onus on consumers. They also have no direct public cost and avoid regressive redistribution impacts, which can be a problem for financial incentives that support EVs.

Pollution fees

Pollution fees charge directly for the pollution that comes out of vehicle tailpipes by adding a fee to the price of fossil fuels. This policy can be used to directly incentivize



Image: International bridge crossing outlet in Southwest Detroit; Gerald Hasspacher.

people to avoid burning gasoline and can help shift the vehicle market toward EVs while also encouraging people to drive less overall. Pollution fees also offer a pathway to generate revenue for programs that further climate and environmental justice goals. On the other hand, pollution fees can be regressive by charging similar amounts to households regardless of income. Many people may have limited alternatives to paying the fee until other policies are implemented to expand access to cleaner forms of transportation.

Another way to disincentivize high-polluting fuels, if designed equitably and with environmental safeguards, is through a low-carbon fuel standard. This policy option requires transportation fuels sold to have an average emissions intensity below a specified threshold. Since using electricity as a transportation fuel can reduce emissions, this type of policy tends to incentivize electricity consumption for EVs over gasoline and diesel. Low-carbon fuel standards can also generate revenue that can be used to support clean and equitable transportation in disadvantaged communities and for low-income households.

EV incentives

As of 2021, EVs tend to be somewhat more expensive than fossil-fuel-powered vehicles, though costs are falling quickly. According to the International Council on Clean Transportation, there is roughly a \$5,000–\$15,000 price difference between EVs and gas-powered cars, depending on vehicle size and EV range.⁴⁴ This difference will likely decline over the coming years with EVs reaching upfront

price parity with fossil vehicles between approximately 2025–2028.

While EV costs are decreasing each year due to improvements in batteries and other technologies, incentives can help make EVs more competitive with gasoline vehicles in the short term. Rebates on the purchase of EVs can help jump-start the market during the early adoption phase. Many states currently offer incentives for the purchase of new clean vehicles to make it easier for consumers to choose EVs when they purchase a vehicle.

One downside to rebates is that they tend to redirect money toward higher income individuals and households, as these groups purchase a disproportionate amount of new personal vehicles. Some states have instituted caps on either the prices of vehicles or the incomes of recipients to limit the flow of incentives to wealthy individuals. California, for example, limits rebates to individuals earning less than \$150,000 and couples earning less than \$300,000. In addition, larger rebates are available to households earning less than 400 percent of the federal poverty limit.⁴⁵

Another way to help incentivize EVs would be to reduce excessive EV registration fees. In Michigan these fees currently recover more revenue from EVs than they do from equivalent gasoline vehicles, which results in a disincentive for driving electric.⁴⁶ The state should consider reducing or even eliminating EV registration surcharges in the short term to help grow the EV market.

CONCLUSIONS

Our analysis finds that cleaning up the transportation sector is vital to Michigan's ability to reach its 2050 decarbonization goal. Putting these policies in place will improve public health and the environment, retain billions of dollars in the state's economy, and promote an equitable transformation of the state's transportation sector. In order to achieve the rapid GHG emission reductions needed to meet its net zero emissions target, Michigan cannot delay in adopting policies that will encourage EV adoption, phase out the sale of new light-duty ICE vehicles by 2035, and decrease reliance on personal vehicles.

APPENDIX

The following appendix provides further information on the modeling methodology used to conduct the analysis described in *Transforming Transportation in Michigan: A Roadmap to Net Zero Emissions in 2050*.

EV-REDI

As noted in the modeling section, EV-REDI was developed by Synapse and first deployed in September 2018. The model is a stock turnover and scenario analysis model which combines a user-specified trajectory of EV sales with state-specific data. This data includes total vehicles on the road, vehicle lifetime distributions, VMT, fuel efficiencies, and emissions rates. Using this information, EV-REDI calculates and reports estimates of future number of EVs on the road, avoided emissions, increased level of electricity consumption, and other outputs. More information about the model can be found on the Synapse website at: <https://www.synapse-energy.com/tools/electric-vehicle-regional-emissions-and-demand-impacts-tool-ev-redi>.

IMPLAN

Our study covered the period 2021–2035, reporting both job-years and net income effects in non-discounted 2019 dollars.

Synapse used IMPLAN to separately estimate the macroeconomic impacts resulting from each of the numerous spending changes associated with accelerated transportation electrification. These changes can be grouped into several categories: changes in spending associated with auto manufacturing, with auto maintenance, with manufacture and installation of charging infrastructure, with fuel switching, and with investments in electric grid generation and distribution system capacity. In turn, these spending changes alter total available discretionary funds for both households and businesses. Over time, both sectors are projected to experience both increases and decreases in “responding” that reflect the net change in expenditures from both the incremental costs and incremental savings of transportation electrification. Table 4 shows the set of spending changes considered in the economic analysis.

Table 4. Spending changes associated with Clean Transportation Scenario considered in analysis

Category	Spending Change	Direction
Auto Manufacturing	Change in spending on battery	Increase
	Change in spending on other electronics	Increase
	Change in spending on auto assembly	Decrease
	Change in spending on R&D	Increase
Auto Maintenance	Change in spending on gasoline engines	Decrease
	Change in spending on auto maintenance	Decrease
Charging Infrastructure	Change in spending on charging infrastructure (Level 2 and DCFC)	Increase
Fuel Switching	Change in spending on gasoline	Decrease
	Change in spending on electricity	Increase
Electric Grid Investments	Change in spending on solar PV capital	Increase
	Change in spending on solar PV operations and maintenance	Increase
	Change in spending on wind capital	Increase
	Change in spending on wind operations and maintenance	Increase
Responding	Change in spending on distribution capital	Increase
	Change in residential responding	Increase
	Change in commercial responding	Increase

Note that all changes are relative to a business-as-usual alternative—thus, spending on gasoline engines in the *Clean Transportation* scenario is lower than in the *Baseline* scenario because there are

fewer gasoline engines built in the *Clean Transportation* scenario. Since IMPLAN projections are based on historical state-level economic data, results may be sensitive to future changes in economic organization and structure that are not reflected in the static analysis.

Calculating grid impacts

The *Clean Transportation* scenario is associated with a marked increase in electricity consumption, resulting in a significant flow of dollars to the utility sector. In this analysis, we assumed that electricity rates would be unchanged between the two cases. We based this assumption on the national price trajectory provided by the U.S. Energy Information Administration's *Annual Energy Outlook*, adjusted for the ratio of average residential rates in Michigan to average nationwide residential rates, and the ratio of average commercial rates in Michigan to average nationwide commercial rates, per the U.S. Energy Information Administration.

We assumed that all new revenues flowing to the utility sector would be used to fund utility system expansion (rather than to finance variable costs associated with operating and maintaining existing resources). To determine how these moneys would be allocated to different system functions, we reviewed recent cost-of-service studies from three major Michigan investor-owned utilities: Consumers Energy, DTE Energy, and Indiana Michigan Power. Together, these three companies comprise about 85 percent of electricity customers statewide. We used the companies' reported plant-in-service totals to calculate share-of-total-state-customers-weighted average allocation factors for generation capacity, distribution capacity, and a catch-all miscellaneous utility functions category. In sum, about 44 percent of new electric sector revenues were flowed to expanding generation capacity, about 47 percent were flowed to expanding distribution capacity, and the residual went to miscellaneous utility functions.

In turn, we calculated annual capacity totals in megawatts using standardized dollar-per-megawatt values from the

National Renewable Energy Laboratory's *Annual Technology Baseline*. Over the full period, we estimated that about 1,555 MW of solar PV and 1,476 MW of onshore wind will be installed. We calculated annual operations and maintenance spending values based on cumulative installed capacity. Finally, annual capital and operations and maintenance spending totals were converted into macroeconomic results using the IMPLAN model.

COBRA

We used EPA's CO-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool to estimate the monetized health impacts of the *Clean Transportation* scenario. COBRA allows users to compare emissions scenarios by adjusting the quantity of criteria pollutant emissions in a policy scenario relative to a baseline scenario. COBRA then projects how changes in criteria pollutants will impact overall changes in $PM_{2.5}$ concentrations between the two scenarios (baseline and policy). Next, the model determines the geographic distribution of changes to ambient $PM_{2.5}$ at a county level. COBRA then translates ambient $PM_{2.5}$ into changes in the occurrence of health outcomes, each of which has an associated dollar value. The overall health impact of a given scenario can then be calculated as the sum of these monetized changes in health outcomes.

We generated the inputs for COBRA by using EV-REDI to project criteria emissions in the *Baseline* and *Clean Transportation* scenarios. The first step was to create the policy scenario within COBRA. This was done by subtracting the delta between the two EV-REDI scenarios from Michigan's baseline on-road vehicle emissions scenario within COBRA. Effectively, this methodology estimates the total reduction in criteria emission in the *Clean Transportation* scenario relative to the *Baseline* scenario, and it applies the same reduction to COBRA's baseline dataset. We used COBRA to estimate health impacts every fifth year beginning in 2025 and ending in 2050, with all values for all other years linearly interpolated. COBRA provides baseline emissions scenarios for a given geography in analysis years 2016, 2023, and 2028. For all years, we used the COBRA baseline emissions scenario for the nearest analysis year available. For instance, in 2025, we used the 2023 baseline scenario whereas for 2030, we used the 2028 baseline

scenario. A key result of the COBRA methodology is that a majority of health impacts are associated with premature deaths; assigning a monetary value to mortality may be both empirically and ethically fraught. Additionally, COBRA was designed to assign either a 3 percent or 7 percent discount rate to all analyses. We used the 3 percent discount rate when modeling health impacts but recognized that there are ethical concerns associated with using any non-zero interest rate as it implies that future lives are less valuable in monetary terms.

A final caveat is that our COBRA modeling only measured health impacts associated with criteria emissions from on-road vehicles. This means that some health outcomes are excluded from our estimate. These would include events such as vehicle crashes, which will likely decrease in the *Clean Transportation* scenario as VMT declines. In addition, we do not capture the impacts of changes in emissions from electricity generation, which will depend in large part on Michigan's ability to transition towards renewables.

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