TRANSFORMING TRANSPORTATION IN NEW YORK

Roadmaps to a Transportation Climate Target for 2035

Prepared on behalf of Sierra Club
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Synapse
Energy Economics, Inc

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Executive Summary

To address the climate crisis, the State of New York has set an ambitious goal to decarbonize its energy use. It has established a mandate to reduce greenhouse gas (GHG) emissions by at least 40% economy-wide by 2030 and achieve 100% net zero emissions by 2050. While the state has made important strides in reducing GHGs, most reductions to date have focused on the electric sector, with far less attention paid to transportation. Yet the transportation sector represents 36% of New York's GHG emissions, making it the largest emitting sector of the economy, with motor vehicles accounting for over 80% of those emissions (see Figure 1 and Table 1).[1] If New York is to succeed in reaching its ambitious emission reduction requirements, it will need specific and bold transportation-focused goals and policies.

This report shows that by adopting a goal of reducing motor vehicle emissions 55% by 2035 from 1990 levels and implementing a suite of familiar and achievable policies, New York can ensure the transportation sector is on track to meet economy-wide goals, improve public health and the environment, retain billions of dollars in the state's economy, and promote an equitable transportation sector transformation.

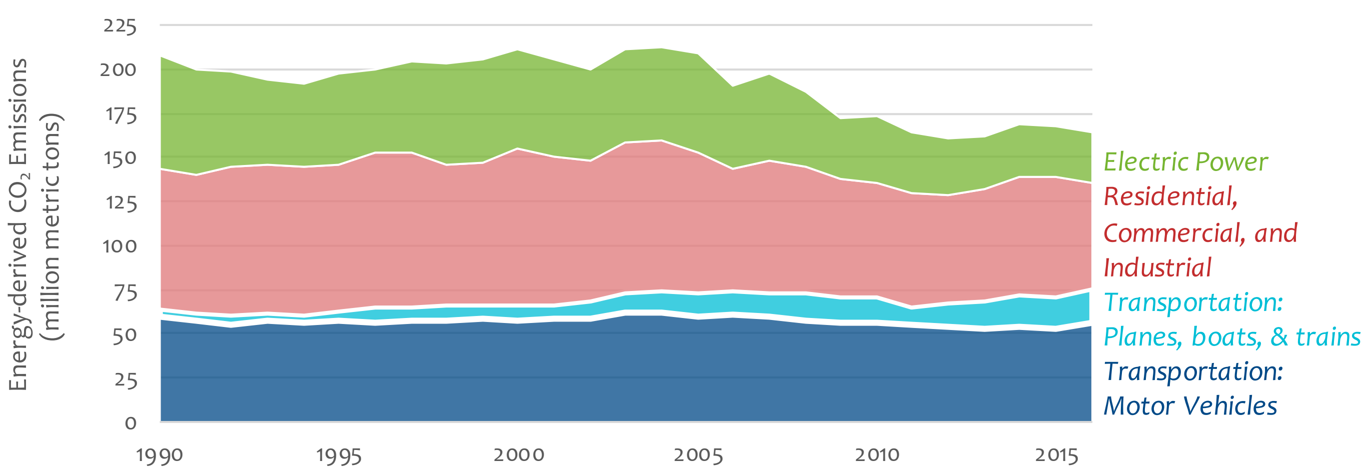
On behalf of the Sierra Club, Synapse Energy Economics modeled three scenarios to evaluate the impacts of incremental policies on vehicle electrification and GHG reductions. We analyzed:

- A **Business-as-Usual (BAU)** future, illustrating the likely impacts of today's policies and expected technological progress;
- An **Electrification Only** future, looking at a set of policies that reduce motor vehicle GHG emissions by 55% by 2035 through increased vehicle electrification; and
- An **Electrification with Mode Shifting** future, examining a set of policies that reduce motor vehicle GHG emissions by 55% by 2035 through a combination of increased vehicle electrification and coordinated policies that reduce reliance on driving by encouraging public transit, walking, biking, telecommuting, and mixed-use development.

We then modeled the public health and economic benefits from the implementation of these policies and the resulting decline in GHG and co-pollutant emissions. Our analysis has six major findings:

1. **Business-as-Usual transportation sector GHG emission reductions are inadequate.** Although transportation sector emissions are projected to

Figure 1. Energy-derived CO_2 emissions in New York



Note: This figure does not include GHG emissions aside from CO_2. It also does not include out-of-state emissions associated with downstream production of goods, emissions from out-of-state power plants that produce electricity consumed in New York, or non-energy emissions (e.g., from agricultural or land-use change).
Source: EIA State Carbon Dioxide Emissions Data. Available at https://www.eia.gov/environment/emissions/state/

decline between now and 2035, absent additional policies, the rate of decline will be insufficient for New York to meet its long-term climate obligations.

2. **GHG reductions of 55% by 2035 from motor vehicles are achievable and will put New York on track to achieve long-term climate commitments.** New York can put itself on track to achieve long-term climate commitments by relying on electric vehicles (EVs) and policies that emphasize low-carbon transportation. By highlighting two potential pathways, we demonstrate that this level of reductions is not dependent on one sole suite of policies—it can be accomplished in multiple ways. Specifically, we find that policies that reduce the upfront cost of EVs, like rebates, and policies that put a price on pollution are particularly effective at spurring adoption of EVs and curbing CO_2 emissions, particularly when coupled with policies that expand access to public EV charging infrastructure.

3. **Acting quickly is critical to achieve substantial GHG reductions by the mid-2030s and put New York on a trajectory for decarbonization by 2050.** Due to long vehicle lifetimes and low fleet turnover rates, aggressive policies are needed imminently to reduce GHG emissions in the next 15 years. According to our research, 53% of all light-duty vehicles (LDVs) sold in New York in 2020 will still be on the road in 2035. In order to reduce GHG emissions by 55% by 2035, New York needs to implement policies that will quickly increase the share of new vehicle purchases that are EVs. Increasing sales of EVs in the near-term significantly impacts the EV share of the entire vehicle fleet by 2035, which is what tailpipe emissions are ultimately tied to (see Figure 2).

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

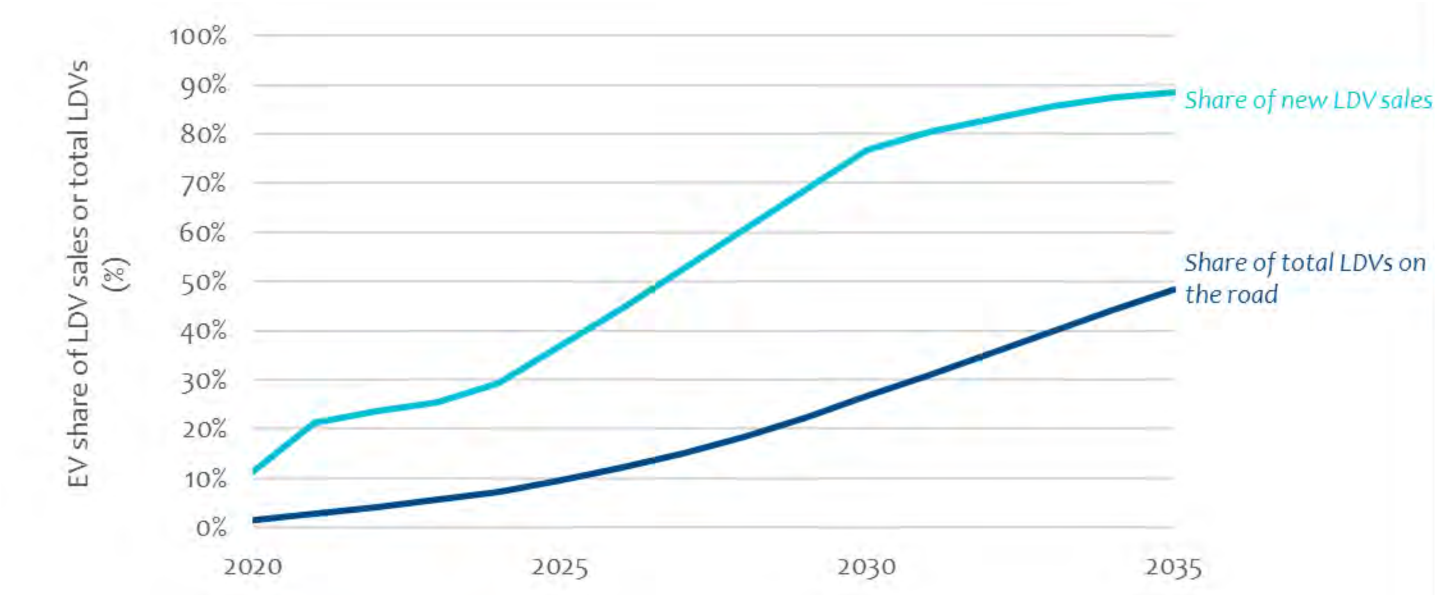
4. **Reducing GHGs from motor vehicles 55% from 1990 levels by 2035 would provide significant economic and public health co-benefits.** Reducing transportation emissions in New York state saves lives, both from decreased exposure to health-damaging pollutants and from reduced motor vehicle injuries and fatalities. It would also save $1.3 to $1.8 billion in healthcare costs beyond business as usual, keep $30

Table 1. New York registered vehicles and CO_2 emissions, 2018 estimate

	Vehicle Count		CO_2 Emissions	
	# of vehicles	*% of*	*million metric tons*	*% of*
All motor vehicles	10,580,000	-	56.5	100%
Light-duty vehicles (LDVs)	*10,120,000*	*96%*	*46.1*	*82%*
Medium-duty vehicles (MDVs)	*250,000*	*2%*	*3.1*	*6%*
Heavy-duty vehicles (HDV): Single	*80,000*	*<1%*	*1.7*	*3%*
Heavy-duty vehicles (HDV): Combination	*40,000*	*<1%*	*3.7*	*7%*
Buses	*90,000*	*<1%*	*1.8*	*3%*
Other vehicles (airplanes, boats, and trains)	-	-	17.3	-
All Transportation	-	-	73.8	-

Note: Light-duty vehicles are any vehicle that weighs less than 10,000 lbs, including SUVs, small and medium pickup trucks, sedans, and other passenger cars. In this analysis, medium-duty vehicles are vehicles that weigh more than 10,000 lbs but less than 26,000 lbs. Heavy-duty vehicles are heavier than 26,000 lbs are and are subcategorized into buses, "single" vehicles (e.g., dump trucks, flatbed trucks or any truck with "single" integrated cab and cargo components), and "combination" vehicles (e.g., semi vehicles that have detachable cab and cargo components.
Sources: NYS DMV. Vehicle, Snowmobile, and Boat Registrations dataset. Available at http://www.dmv.ny.gov/register.htm; EIA State Energy Data System. Available at https://www.eia.gov/state/seds/; Synapse's EV-REDI Model.

Figure 2. EVs as a share of LDV sales and total LDVs on the road (Electrification Only scenario)



to 31 billion of transportation fuel expenditures in-state, and boost economic productivity by lowering the number of work days lost.

5. **Clean transportation policies must be equitable.** This includes distribution of both benefits (e.g., air quality and mobility) and costs. For example, policymakers can prioritize the electrification of vehicles that produce the most health-damaging emissions, especially since these vehicle types (such as buses and short-haul trucks) disproportionately emit these pollutants in neighborhoods that are largely composed of low income residents and in communities of color. Policymakers can also ensure that funds raised from pollution fees are recirculated to low income communities and communities of color in the forms of improved public transportation, EV car-sharing, and active transportation infrastructure, for example.

6. **Supporting the move to electric vehicles is essential.** Achieving significant reductions will require rapid, widespread transportation electrification. This will necessitate support from state agencies, municipalities, the private sector, and utilities. Support for policies that encourage EVs over conventional vehicles, such as strong rebates for EVs, result in the build-out of publicly accessible charging infrastructure, and promote less driving overall will be essential. Furthermore, policies must ensure electrification happens across all vehicle types, not just LDVs.

The following report describes our methodology and findings.

New York's Clean Energy Leadership

New York has recognized the importance of mitigating the climate crisis, which threatens to extend dangerous extreme heat waves, cause sea level rise and storm surges that will eventually subsume coastal communities, and increase health risks and deaths resulting from worsening air quality and hotter temperatures.[2]

In July 2019, Governor Cuomo signed the New York Climate Leadership and Community Protection Act (CLCPA).[3] Recognizing the urgency of reducing GHG emissions to mitigate the threat of climate change, the law requires New York to reduce emissions at least 40% from 1990 levels economy-wide by 2030 and reach 100% net zero by 2050.[4] Important steps have been taken already to ensure that electric sector emissions decline in line with the targets. The CLCPA requires that renewable resources account for 70% of electricity generation by 2030 and that electric sector emissions decline to zero by 2040.[5] To help meet those ambitious targets, the law requires the procurement of 9,000 MW of offshore wind power, 6,000 MW of distributed solar, 3,000 MW of battery storage, and investments in energy-saving measures that will also reduce energy costs. For the CLCPA's mandate of 100% net zero GHG emissions by 2050, a minimum of 85% of reductions must come from cutting emissions—the remaining 15% can come through offsets. Some sectors of the economy will be more difficult to decarbonize, such as air travel and industrial processes, as the technologies for emissions reductions in these categories are still in earlier stages. As noted above, the transportation sector accounts for 36% of New York's emissions, with motor vehicles accounting for 76% of that. Given that the technology exists today to reduce GHG emissions from motor vehicles, it is critical for New York to implement policies in this sector that will slow harmful climate change and meet state goals.

New York's progress so far

Fortunately, New York has taken important first steps in decreasing carbon pollution from the transportation sector. For example, some progress has already been made, or committed to, by New York's regional transit agencies. Given their fixed and relatively short routes, transit buses are a great early application of EVs. MTA, the New York City metropolitan area's transit authority, has set a target to transition to a zero-emissions fleet by 2040.[6] Other regional transit authorities have also taken steps to move toward zero emissions electric buses. For example, Rochester's Regional Transit Service is purchasing six electric buses and plans to acquire more in the future.[7]

New York has also taken steps to increase the number of EV charging stations available in the state. Through the EVolve NY program, the NY Power Authority has committed to invest $250 million in EV infrastructure, services, and awareness efforts to help build the backbone of EV chargers in the state.[8] NYSERDA's Charge Ready NY program helps organizations install charging ports by providing a rebate of $4,000 per port.[9] There is also a $5,000 tax credit available for installing chargers at commercial buildings and workplaces.[10] New York supports the purchase of EVs directly as well: As a member of the ZEV states that follow California's zero emission vehicle regulation, New York requires that a growing fraction of the vehicles sold by each auto manufacturer be electric.[11] On top of that, New York currently provides consumers rebates of up to $2,000 for the purchase of an EV.

In addition, New York City and other urban centers already have extensive public transportation networks, as well as many neighborhoods that provide access to important services within walking and biking distance. These features provide residents with many sustainable transportation options and reduce the total distance that residents need to travel. The upcoming implementation of congestion pricing in New York City will more accurately reflect the advantages of sustainable transportation modes over polluting motor vehicles. Other programs, such as Climate Smart Communities, can play a large role in reducing emissions, and New York can reduce the amount people have to drive through Complete Street re-designs and by bolstering affordable and accessible public transit. Even in parts of the state that are more reliant on cars, including rural areas, higher quality active and public transportation options combined with investments in and expanded use of clean electric vehicles could provide residents more choices at lower costs.

Now the state must build on these policies by taking bold and ambitious actions to reduce emissions from cars, buses, and trucks and to meet economy-wide emissions reduction targets.

Where New York needs to go

While the policies implemented to date will help cut into New York's transportation sector climate emissions, our analysis of a business-as-usual future shows that they will not move the needle far or fast enough to meet long-term commitments. Consequently, New York must take bigger, bolder, and more ambitious action to reduce transportation-sector emissions through policies that ensure such a transition is equitable. By implementing policies at the scale needed to achieve 55% reductions by 2035, New York can build on this leadership and fulfill the promise of being a national climate leader.

Policies that have been shown to accelerate transportation electrification include those that reduce the upfront price disparity, such as strong EV rebates, rapidly expanding the fueling infrastructure for EVs, and reflecting the true cost of internal combustion engines through such things in increases in fuel prices. The following sections explore the modeled effects of these policies and their impacts on meeting New York's 2035 target.

Analysis Methodology

We performed our analysis using two models: the Market Acceptance of Advanced Automotive Technologies (MA3T) model and the Electric Vehicle Regional Emissions and Demand Impacts (EV-REDI) model. MA3T is a consumer adoption model focusing on LDVs, developed by Oak Ridge National Laboratory and most recently updated in April 2019. We used it to assess the annual impacts of technology changes and transportation sector policies on the share of EVs relative to total LDVs .

Meanwhile, EV-REDI was developed by Synapse and deployed in September 2018. EV-REDI is a stock turnover and scenario analysis model. We took outputs from MA3T in the form of EVs sold per year (as a share of total LDVs sold) and evaluated them in EV-REDI to estimate the number of EVs on the road, CO_2 emissions, reductions in gasoline and diesel consumption use, and other outputs.

See this document's appendix for more detail on the analysis methodology and models used.

Modeling and Results

We used scenario analysis to examine the potential impacts of changing incentives that impact vehicle purchases and reduce total vehicle miles driven. We did not investigate all potential scenarios or attempt to identify the most likely scenarios—instead, we aimed to understand the impact of a subset of known and available EV policies on several possible futures. Table 2 describes in detail the policies assumed in each scenario. At a high level, the modeled policies include: (a) increasing the availability of public charging infrastructure; (b) increasing EV rebates; (c) internalizing the cost of pollution from ICEs; and (d) shifting transportation modes to reduce VMTs. In addition to the policies described in Table 2, we modeled the following policies as the same across all scenarios:

- **Internal combustion engine (ICE) vehicle efficiency:** In all scenarios, we assumed that ICE fuel efficiency increases slowly after 2021. For example, passenger car efficiency increases from about 34 MPG in 2021 to 37 MPG in 2035 and light truck efficiency increases from 25 MPG in 2021 to 26 MPG in 2037. These trajectories are based on the 2018 EIA Annual Energy Outlook's "No New Efficiency Requirements" case, adjusted to match historical EPA fleet-average efficiency data. Given uncertainty regarding clean car standards at the federal level, we assumed a rollback of standards, to ensure proposed EV policies could achieve emissions reductions independent of federal action.

- **EV mandates:** We compared preliminary results to existing EV mandates, including New York's ZEV mandate. Rather than evaluating these policies as inputs, we examined whether the number of EVs produced by each modeled scenario met or exceeded the mandated EV requirements from each policy. In each scenario, the modeled policies resulted in a number of EVs that exceeds the mandated number of EVs under New York's ZEV mandate. This does not mean that the ZEV mandate is not important; rather it means that by adopting the other state policies reflected in the modeling, New York can advance electrification and help insulate its carbon emission reduction objectives even in the face of a federal rollback of ZEV mandates.

Table 2. Scenario descriptions and assumptions

	Business-as-Usual	Electrification Only	Electrification with Mode Shifting
Description	Models likely EV adoption resulting from current policies and expected future technological progress and cost declines	Models a set of policies that reduce motor vehicle emissions 55% by 2035 through rapid electrification of motor vehicles	Models a set of policies that reduce motor vehicle GHG emissions by 55% by 2035 by shifting to more sustainable modes of transportation alongside electrification
Public charging access	Held flat at present-day levels (chargers are only 20% as convenient to access as gas stations)	Public chargers are as accessible as gas stations by 2027; number of gas stations declines at the rate observed in recent years	Public chargers are as accessible as gas stations by 2027; number of gas stations declines at the rate observed in recent years
Rebates	Current rebates: vehicles with all-electric ranges of >120 miles have a $2,000 rebate, while other vehicles (e.g., PHEVs) have progressively lower rebates	(1) Increases the $2,000 rebate to $5,000 in 2020 and (2) reduces the relative cost of EVs as compared to ICEs by an additional $500 per year in 2025 that ramps up to $3,000 in 2030	(1) Increases the $2,000 rebate to $3,800 in 2020 and (2) reduces the relative cost of EVs as compared to ICEs by an additional $500 per year in 2025 that ramps up to $3,000 in 2030
Pollution fees	None	Additional gasoline fee of $0.274/gallon beginning in 2022 and increasing by $0.05 each year between 2025 and 2030	Additional gasoline fee of $0.274/gallon beginning in 2022 and increasing by $0.05 each year between 2025 and 2030
VMT	VMT per vehicle remains constant	VMT per vehicle remains constant	VMT per LDV reduced by 7.5% total between 2020 and 2035; VMT for non-LDVs remains the same as in the BAU
BEVs vs. PHEVs	The fraction of new EVs that are full BEVs is 68% in 2020 and increases to 83% by 2035, in line with recent national modeling by BNEF	Assumes fewer PHEVs are produced relative to the BAU, resulting in BEVs making up 93% of EV sales in 2035	Assumes fewer PHEVs are produced relative to the BAU, resulting in BEVs making up 93% of EV sales in 2035
MDVs & HDVs	All vehicles follow "medium" or "slow" electrification trajectory	Buses follow "fast" trajectory; all other vehicles follow "medium" or "slow" electrification trajectory	Buses follow "fast" trajectory; all other vehicles follow "medium" or "slow" electrification trajectory

EV sales

Figure 3 shows how the EV share of all new cars is projected to change through 2035. In the BAU projection, New York's EV sales share increases rapidly from 2018 to 2021 while the federal tax credit is still in effect for many auto manufacturers.[12] EV sales shares then hold flat through the early-2020s as the current tax credit phases out and as the upfront cost of purchasing an EV drops. Starting around 2025, EV sales shares increase again as the upfront cost of many types of EVs falls below their ICE equivalent. Finally, growth in EV sales slows in the early 2030s and later years as EV technology matures and price declines slow. In 2035, EVs make up only 58% of all new LDVs sold in New York in a BAU projection, lower than what is needed to reach emissions goals.

In the Electrification Only scenario, increased rebates and other incentives result in higher levels of EV sales. EV sales shares are between 20 and 30% for much of the early 2020s. By 2035, EVs make up 88% of all new LDVs sold in New York. The Electrification with Mode Shifting scenario features a similar, but lower trajectory because fewer EVs are needed to achieve the same CO_2 reductions by 2035.

EVs on the road

Even if New York were to achieve a rapid adoption of EVs in terms of new vehicle purchases, low fleet turnover means that it will take a long time until EVs comprise a substantial amount 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 one-third of all new LDVs sold in 2025 are EVs under the Electrification Only scenario, EVs represent less than 10% of all LDVs on the road in that same year. In that same scenario, EVs are almost 90% of sales in 2035 and yet under 50% of all LDVs on the road in 2035 are electric. In the Electrification Only scenario, there are projected to be 5.1 million LDV EVs on the road in New York in 2035, compared to about 45,000 on the road in 2018.

Figure 3. EV sales a % of new vehicle sales, LDVs only

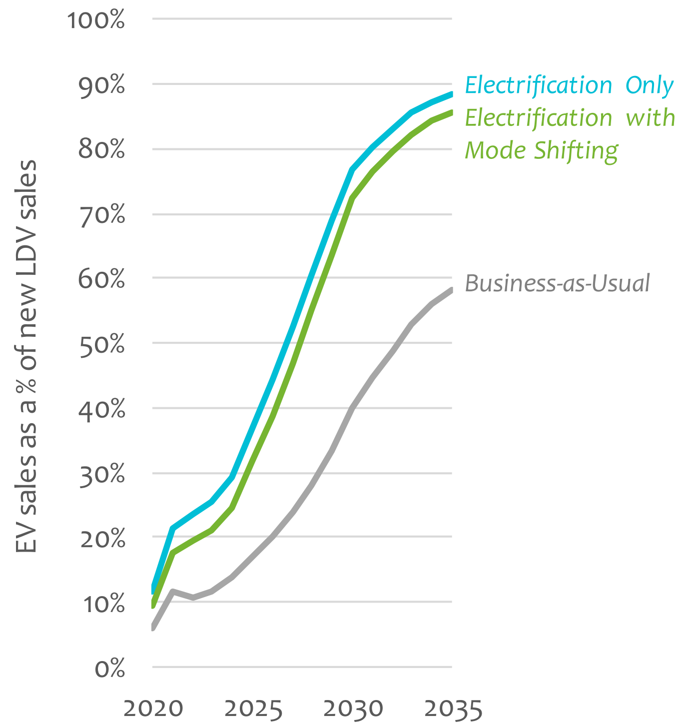
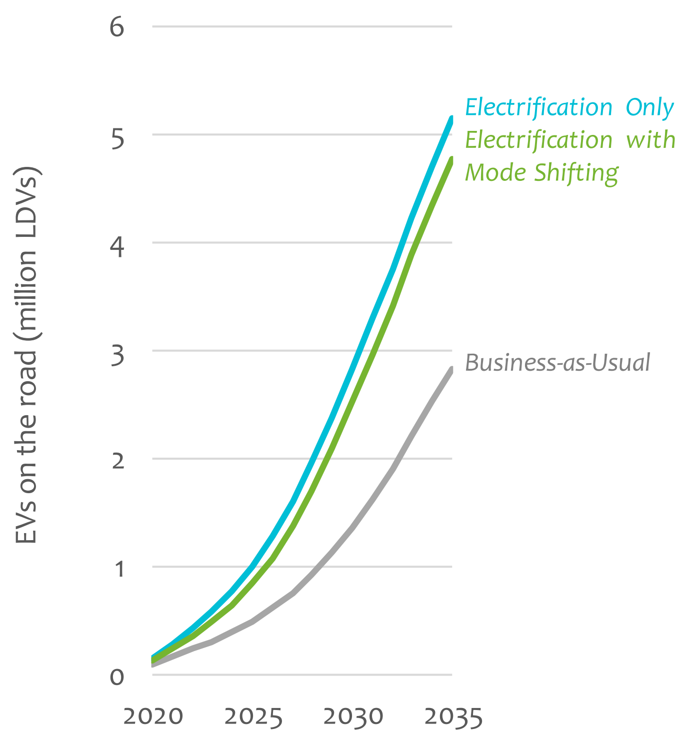


Figure 4. EVs on the road, million LDVs



Note: We estimate that there were about 10.1 million LDVs on the road in 2018.

Medium- and heavy-duty EVs

We also estimated adoption trajectories of medium-duty vehicles (MDVs) and heavy-duty vehicles (HDVs) to determine the total reduction in motor vehicle CO_2 emissions. Figure 5 and Figure 6 show new EV sales and total EVs on the road in the MDV and HDV segment, respectively.

MDVs and HDVs include many different types of vehicles, and thus have a less smooth adoption curve. Some types of vehicles (such as transit and school buses) electrify rapidly and others (such as long-haul freight trucks) take much longer. In both the Electrification Only and Electrification with Mode Shifting scenarios, all buses are electric by 2040, in line with MTA's goals and suggesting a policy that follows California's requirement to transition to zero-emissions buses by 2040. See this document's appendix for information on how non-LDV sales trajectories were developed.

Impacts of modeled policies

The increase in EVs we see in the Electrification Only and Electrification with Mode Shifting scenarios is a result of a combination of modeled policies, but not all policies have equal-sized impacts. To compare the effects of individual policies, we ran sensitivity scenarios in which only one policy was added to the BAU scenario at a time. We then analyzed the change in EV sales in 2035 between the BAU scenario and the sensitivity scenarios, comparing the observed difference to the total change in 2035 EV sales observed between the BAU and Electrification Only scenarios.[13]

We find from this sensitivity analysis that measures to reduce the upfront cost of EVs relative to ICE vehicles (such as rebates) have the largest effect on EV sales. For example, we estimate that this type of policy alone achieves 86% of the total increase EV sales between the BAU and Electrification Only scenarios. Lowering the relative upfront cost of EVs compared to ICE vehicles will be critical to accelerate the adoption of EVs.

Pollution fees on gasoline (including those linked to the regional Transportation and Climate Initiative), also help

Figure 5. EV sales a % of new vehicle sales, MDVs and HDVs

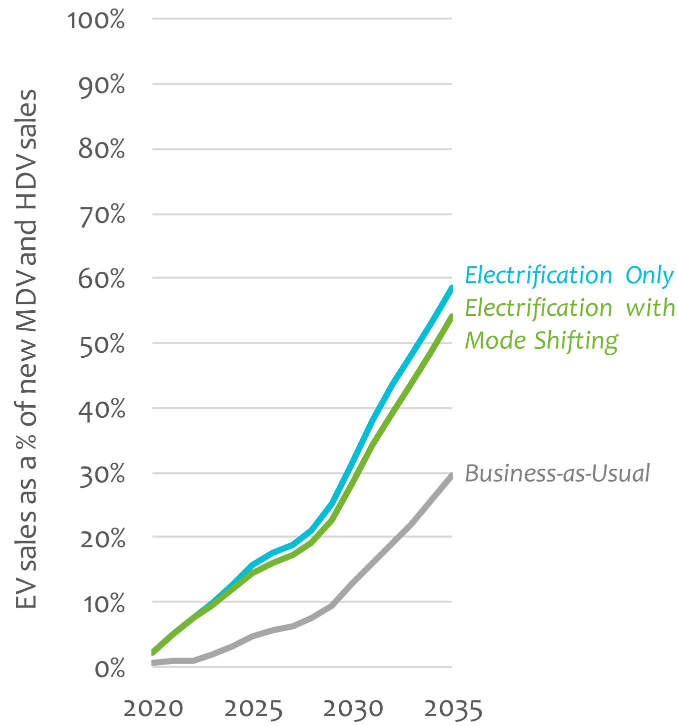
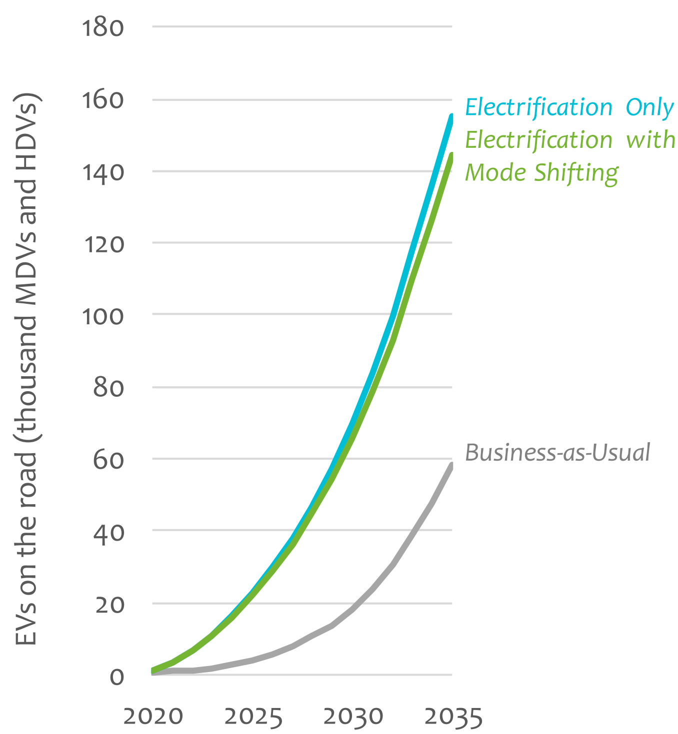


Figure 6. EVs on the road, thousand MDVs and HDVs



Note: Unlike Figure 4 (see previous page), values in this figure are presented in thousands rather than millions for purposes of readability. We estimate that there were about 420,000 MDVs and HDVs on the road in 2018.

to strengthen the economics of purchasing an EV by increasing the operational savings over the lifetime of the vehicle.[14] On its own, the pollution fee modeled in this analysis would achieve 23% of the increase in EV sales seen between the BAU and Electrification Only scenarios. In addition to having a substantial impact on EV sales, pollution fees raise revenue to fund other policies, such as rebates for EVs or increased funding for public transit. By raising the cost of polluting and providing essential revenue to fund sustainable transportation options, pollution fees achieve multiple important policy objectives at once.

Access to convenient charging is a prerequisite to EV adoption for most car buyers. While increased access to public Level 2 charging (in the MA3T model, public charging does not include workplace, home, or curbside charging) by itself yields only a modest 7% of the increase in EV sales between the BAU and Electrification Only scenarios, an absence of public chargers can significantly hamper efforts to promote vehicle electrification. Significantly, our analysis of charging infrastructure buildout is limited to Level 2 chargers in public spaces. It does not include DC fast chargers, which play an important role in overcoming "range anxiety," or home or workplace chargers. Increasing access to Level 2 charging at homes and workplaces, in addition to public locations, can reduce and reverse the existing ICE vehicle advantage in refueling convenience and also help to decrease range anxiety.

To understand the potential impact of larger scale charging infrastructure investments, we analyzed an additional sensitivity scenario in which by 2035 all drivers have access to Level 2 charging at home, even those without driveways or other off-street parking. This level of charging infrastructure results in an increase in EV sales of 56% of the total increase observed between the BAU and Electrification Only scenarios. While there are significant obstacles to charging at home for many drivers, particularly in large urban areas like New York City, the sensitivity illustrates that enabling charging at or close to all homes, including multi-family dwellings, would be critical to facilitating EV ownership for many New Yorkers.

Additionally, ensuring a rapid buildout of DC fast charging, which is not modeled in this analysis, could also help fill gaps in Level 2 charging access and enable long trips that require quick recharging on the road.

Other policies can play important roles, even if they have not been quantified in this study. Policies that increase awareness of EVs will be particularly important in the coming years while EV adoption remains concentrated among early adopters. For example, informational events where interested consumers can talk to current EV owners and learn about available electric models can help answer people's questions and concerns, while correcting misinformation. Similarly, policies that help to train car dealerships on the strengths of EVs could result in more consumers choosing an EV when it is time to purchase their next vehicle.

Table 3. Policies to decrease VMT

Providing transportation choices	Discouraging unsustainable motor vehicle travel
Mixed-use and transit-oriented zoning is essential to enable walking, biking, and public transit. Mixed-use buildings in concentrated areas reduce the distances between residents and the jobs and services they rely on, which makes walking and biking more feasible. Zoning for transit-oriented development while maintaining affordability gives more people convenient access to transit and makes more of the places they need to go accessible by transit.	**Congestion pricing and VMT fees** charge drivers for some of the congestion, infrastructure, and land use costs they impose. Congestion pricing focuses on reducing traffic in city centers, thus opening up road space for public and active forms of transportation. VMT fees assign infrastructure maintenance costs to drivers, usually proportionally to the degree to which each driver is using roadways. Both policies encourage more efficient transportation modes.
Public and active transportation infrastructure includes pedestrian paths and sidewalks, bike paths and lanes, bus rapid transit routes, and rail infrastructure. These investments make public and active transportation feasible and convenient and allow people to choose the transportation modes that work best for them.	**Road diets** reduce the reliance on motor vehicles by adjusting streets to match their surroundings. Roads through populated areas that have too many lanes or high-speed limits are dangerous, unsustainable, and harmful to quality of life.[15] Creating streets that consider the needs of all roadway users can encourage drivers to consider other modes instead.
Maintaining fare affordability is critical to making transit accessible to everyone. Lower fares also reward transit riders for the benefits they provide to the entire transportation system by occupying less space on roadways, improving transportation safety, and reducing energy use and pollution.	**Reducing parking requirements** frees up more space for people. Vehicles take up valuable space—parking mandates subsidize this cost by artificially increasing the supply of parking. Requirements for extensive parking also raise development costs, create sprawl that makes walking and biking more difficult, and favor motor vehicle travel over public transportation.

Potential for VMT reductions

Reducing the number of miles driven in motor vehicles is a significant challenge. Driving habits depend on many factors, including land use patterns that evolve slowly and individual preferences that can be difficult to change. The Electrification with Mode Shifting scenario assumes that a comprehensive set of policies can achieve a 5% reduction in light-duty VMT each decade (totaling 7.5% by 2035) relative to a BAU future. This aligns with possible VMT reduction estimates from several studies (see appendix). We assumed this reduction bearing in mind that our scenario looks at VMT reductions state-wide, while reductions associated with one specific policy tend to reflect changes in more localized areas.

Changing land use patterns and supply of alternative transportation modes can change the relative convenience of driving, walking, biking, and taking transit. To accomplish this, New York can implement two categories of policies: those that provide more transportation options and those that create disincentives for driving by charging vehicles for the costs they impose on society. Some policies that can be implemented to provide convenient, affordable, and sustainable alternatives to driving are described above in Table 3. See this document's appendix for more detail on VMT reduction potential.

Policies to improve charging infrastructure

To rapidly increase the adoption of EVs, it is essential to support the buildout of public charging infrastructure. Consumers will be more likely to choose EVs if they know that charging will be easy and convenient, regardless of whether they are driving locally or for longer distances.[16] In both the Electrification Only and Electrification with Mode Shifting scenarios, we projected that public chargers are as accessible as gas stations by 2027 and that the number of gas stations declines at the rate observed in recent years. This assumption represents a destination, but not the policies needed to get there. There are a variety of tools for New York to expand upon and complement to make this level of convenience a reality across the state.

New York has already put some policies in place to encourage the deployment of EV charging infrastructure, including rebates and tax credits for public and workplace charging stations. Furthermore, the state is spending $19.2 million from the VW diesel settlement on charging infrastructure for LDVs. Additional policies can accelerate the deployment of EV charging infrastructure even faster.

One important component of the EV charging network will be DC fast chargers, which can help EV charging compete with refueling an ICE vehicle at a gas station. They can also serve drivers on long trips or who have limited access to charging at homes or workplaces. Some of the popular EVs available today can restore up to 160-197 miles each hour, but new DC fast chargers can deliver the same amount of driving range in just ten or twenty minutes.[17] New York can invest funding in the next generation of ultra-fast DC chargers, particularly in underserved communities where the market has failed to provide adequate charging access.

As New York expands the availability of fast charging stations as well as standard plugs and level 2 chargers at workplaces, multi-unit dwellings, and other destinations, utilities can help fill in where the market has been lacking. In the near term, electric companies can help build out infrastructure to reduce range anxiety, encourage more drivers to go electric, and utilize existing electric grid infrastructure to provide more electricity. By spreading fixed grid costs over more energy sold, these utility investments can bring down costs for all customers.

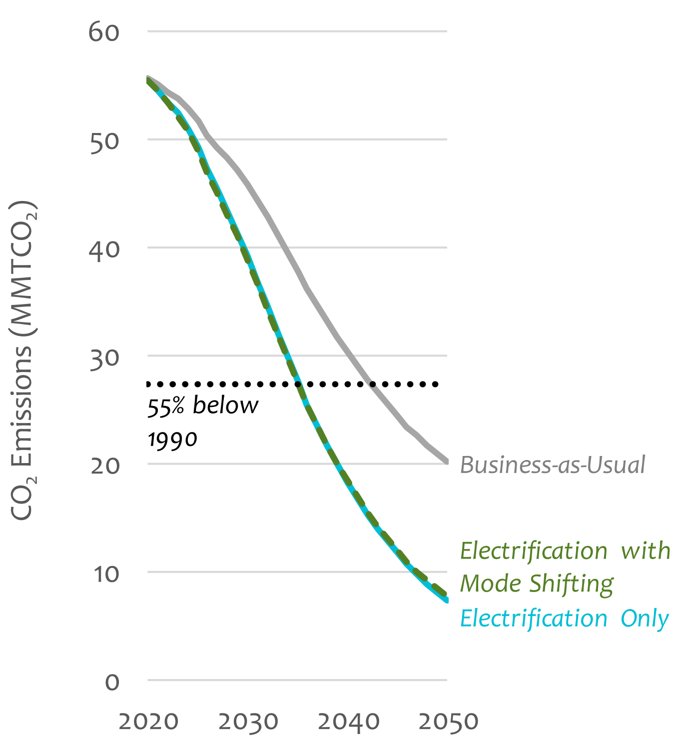
Utilities can also accelerate EV deployment with rate designs that both lower the costs EV drivers pay for charging and the costs that charging imposes on the grid. Time-of-use (TOU) rates, which charge different amounts for electricity at different times of the day, can help save EV drivers money by encouraging them to charge their EVs at low cost hours, when it is easier and more efficient for the grid to serve this vehicle charging load. Public charging stations offer an additional opportunity for utilities to design rates that encourage EV adoption. High demand charges, which charge customers based on the maximum amount of electricity used at any moment over the course of the month, can be very expensive for charging stations that are only occasionally used in the near term (while EV sales are still relatively low). Instead, utilities can develop rates that depend on the amount of energy these stations consume and the hours during which the energy is consumed.

New York State and the Public Service Commission should direct the utilities to take faster, smarter, and more significant action to facilitate the transition to an electrified transportation system. Such policies could include load-balancing, battery storage, vehicle-to-grid programs, as well as programs that incentivize EVs, renewables, and smart grid improvements.

EVs and CO_2 emissions

Increasing the number of EVs on the road reduces tailpipe emissions from motor vehicles (see Figure 7). Even in the BAU scenario, tailpipe CO_2 emissions are reduced by 38% in 2035, relative to 1990 levels. This reduction is a result of anticipated improvements and cost reductions in EV technology, improvements in ICE efficiency, and current New York policies that drive EV adoption. The Electrification Only and Electrification with Mode Shifting scenarios result in greater emissions reductions, with both scenarios reducing CO_2 emissions by nearly 20% in 2025 and 55% in 2035. Further out in the study period, both policy scenarios reduce CO_2 emissions from motor vehicle tailpipes by approximately 90% by 2050. Under the BAU, emissions from motor vehicle tailpipes decline by just 67% by 2050. In order to achieve 100% net zero emissions by 2050 economy-wide, motor vehicles will likely need to get as close to 100% direct reductions as possible, given the technological barriers to decarbonizing other sectors.

Figure 7. Motor vehicle CO_2 emissions



Note: This figure includes tailpipe emissions from all motor vehicles, including LDVs, MDVs, HDVs, and buses. It does not include CO_2 emissions that may result from charging.

EVs and the electricity grid

Under each projected scenario, EVs are expected to require a substantial amount of electricity, although not for several years. For example, by 2025, we project an increase in wholesale electricity consumption of 6.1 TWh in the Electrification Only scenario. Per the energy forecast in NYISO's 2019 Gold Book, this represents a 4% increase in electricity consumption by 2025.[18] For comparison, NYISO estimated that historical electricity consumption changed 3% between 2017 and 2018. By 2035, the Electrification Only scenario projects an increase of nearly 30 TWh of electricity, or about a 17% increase over what NYISO projects for 2035.

Importantly, if New York fulfills the requirements set out in the CLCPA to transition to 100% carbon-free electricity by 2040, the additional demand for electricity from EVs will not result in incremental CO_2 emissions from the electric sector in the long term.

EVs and public health

As EVs proliferate, they avoid not only emissions of CO_2, but also other pollutants dangerous to human health. More than 12.5 million New Yorkers (64% of the state's population) live in counties designated as failing to meet health-based ambient air quality standards for smog.[19] The transportation sector is responsible for over 55% of total national emissions of nitrogen oxides, a primary smog precursor.[20]

Using Synapse's EV-REDI model, we estimated reductions of criteria pollutants (e.g., sulfur dioxide, nitrogen oxides, and particulate matter) 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 most recent report from the New York State Department of Public Health, asthma rates for all age groups are on the rise and asthma -related emergency visits in the state were higher than the national average.[21]

Using U.S. EPA's COBRA model, we can estimate avoided health incidences and associated monetized benefits.[22] Over the entire study period of 2020 to 2035, we estimate that the increased number of EVs in the Electrification Only scenario (relative to the BAU) will cumulatively avoid 128 premature deaths, eliminate 73,800 work loss days, and result in monetized health benefits of $1.3 billion (see Table 4).

Table 4. Cumulative statewide health benefits, 2020 to 2035, relative to the BAU scenario

	Electrification Only	Electrification with Mode Shifting
Monetized health benefits	$1.3 billion	$1.8 billion
Avoided lost work days	73,800	102,400
Premature deaths avoided	128	178

Note: "Monetized health benefits" include direct medical and societal costs associated with premature deaths, avoided lost work days, and improved public health, presented in 2018 dollars.

Meanwhile, the Electrification with Mode Shifting scenario will avoid a cumulative 178 premature deaths and 102,400 work loss days, and produce cumulative health benefits valued at $1.8 billion as a result of both EV deployment and reduced VMT. 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. The benefits are larger in the Electrification with Mode Shifting scenario because the VMT reduction is applied to all vehicles across the existing fleet of vehicles on the road and therefore helps to reduce emissions from older vehicles, which are the worst polluters.

In addition, the numbers described here only quantify the public health benefits achieved as a result of the decreased emissions in each policy scenario relative to the BAU; 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 of sulfur dioxide, nitrogen oxides, and particulate matter will be reduced.

EVs and the economy

Transitioning away fossil fuel dependence for transportation will provide a boost to New York's economy. In 2017, New York was sixth in the nation in terms of total petroleum consumption, with 80% of these fuels (totaling 202 billion barrels of gasoline, diesel, and other fuels) burned in the transportation sector.[23] Virtually all of this petroleum was extracted and refined outside of New York, with expenditures totaling $20 billion in 2017. Between 2020 and 2035, we estimate that the Electrification Only scenario will cumulatively reduce expenditures on out-of-state gasoline and diesel by $30 billion, relative to the BAU scenario. Likewise, we estimate the Electrification with Mode Shifting scenario to reduce cumulative expenditures on fossil fuels by $31 billion, relative to the BAU scenario.[24]

As New York moves to a 100% renewable electric grid, the majority of this power will come from in-state renewables like wind and solar. Thus, electrifying transportation would allow the state to shift energy expenditures away from out-of-state purchases of oil to in-state purchases of locally-generated electricity and keep this money in the New York economy.

Discussion and Conclusions

Reducing motor vehicle GHG emissions 55% by 2035 is achievable, but it will require fast, strategic, and bold action by the state. At stake are the health and wellness of millions of New Yorkers, billions of dollars in potential fuel and health savings, and the ability of New York to avert catastrophic climate change. The results of our analysis make it clear that immediate action is needed to electrify a wide array of different vehicle types. Only such action will keep New York on track to decarbonize by 2050. This transition should ensure that the benefits of electrification are shared equitably by all of New York's residents.

Business-as-Usual transportation sector GHG reductions are inadequate

Our BAU projection shows transportation sector emissions declining through 2050 as a result of existing policies and projected technological advancement, but this alone will not be sufficient to ensure New York is on track to achieve 100% net zero emissions by 2050. Given the slow rate of vehicle turnover, it is important to quickly identify a trajectory that can get New York on track to successfully achieve its climate commitments. As discussed below, an interim reduction target of 55% by 2035 for motor vehicles can help ensure that New York is on target with its long-term goals.

Reducing emissions 55% by 2035 is possible and puts New York on track to meet long-term climate commitments

Achieving substantial GHG reductions over the next 15 years is essential for New York to both meet the mandate under CLCPA and help avoid catastrophic climate change. Our modeling shows that by expanding policies that are in place today, New York can reduce GHG emissions from motor vehicles by 55% compared to 1990 levels by 2035 and put the state on track to achieve its long-term targets. In addition, our analysis indicates that multiple suites of policies can achieve the 2035 goal. This includes policies that aggressively promote EVs, such as rebates, pollution fees, and charging infrastructure, as well as those that reduce VMT.

Acting fast is critical to achieving long-term GHG reductions

Internal combustion engine vehicles sold today will be on the road and emit climate-warming emissions for 15 to 20 years, or more. Our research indicates that 53% of all LDVs sold in New York in 2020 will still be on the road in 2035 and that nearly 20% of these vehicles will be on the road in 2040.[25] At the same time, increasing the market share of EVs will take time, in large part because of the higher upfront costs of these vehicles today. In order to reduce GHG emissions by 55% by 2035, New York will need to invest in aggressive policies to overcome this cost barrier, such as easing the phase-out of the $7,500 federal tax credit for EVs and widening the ongoing savings associated with EV operation (e.g., fueling and maintenance savings). New York should also double-down on policies that help EVs compete with more mature ICE infrastructure by improving charging availability and reducing range anxiety among potential EV adopters who are concerned about the technology's real or perceived limitations.

Emissions from other vehicles

Non-motor vehicles create another major obstacle to the decarbonization of the transportation sector. These vehicles include airplanes, boats, and trains. In recent years, they have represented about one-quarter of all transportation sector emissions. Of this non-motor vehicle fraction, airplanes make up the lion's share of emissions in New York—75 to 80% in recent years. As domestic and international air travel increases, airplanes are projected to account for 85% of non-motor vehicle GHG emissions by 2035. Currently, there are few commercially viable technologies to decarbonize airplanes, outside of mode-shifting to other forms of transportation (e.g., Amtrak). In order to achieve higher levels of economy-wide emission reductions, more investment will be needed to develop low-carbon alternatives that move people across long distances.

Furthermore, New York can expand on policies that put a price on CO_2, such as through traditional gasoline taxes, participation in the regional Transportation and Climate Initiative (TCI), other carbon pricing mechanisms, or programs like New York City's proposed congestion pricing. Swift deployment of these types of programs can help simultaneously raise revenue for policies such as EV rebates and disincentivize reliance on fossil fuel-powered vehicles.

Reducing motor vehicle emissions 55% by 2035 can produce economic and public health benefits

Aggressively reducing emissions from motor vehicle transportation in New York State will have co-benefits beyond climate change mitigation. Burning fossil fuels in motor vehicle transportation produces health-damaging tailpipe pollutants, leading to lost work days, illness, and death and costing billions of dollars in healthcare costs. New Yorkers spend $20 billion each year on gasoline and diesel to power their vehicles, virtually all of which is produced and refined outside of the state. Electric vehicles avoid these devastating health impacts, with the aggressive policies modeled here producing $1.3 to $1.8 billion in public health benefits. These same policies can shift the flow of transportation dollars from out-of-state oil to in-state renewable energy and in-state jobs, and can reduce gasoline and diesel expenditures of $30 billion or more from 2020 to 2035.

Clean transportation policies must be equitable

As New York moves to decarbonize its transportation sector, impacts on low income communities and communities of color should be carefully considered to ensure that the transition is made equitably for all residents.

First, policymakers can make the electrification of vehicles that emit criteria pollutants a priority in low income communities and communities of color that are disproportionately burdened by air pollution. A 2019 analysis by the Union of Concerned Scientists titled Inequitable Exposure to Air Pollution from Vehicles found that New Yorkers who identify as Asian American, Latino, African American, or "other race" (not white) are exposed to 28 to 47% more particulate matter pollution from cars, trucks, and buses than white New Yorkers.[26] 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.[27] Low-income New Yorkers 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), New York can prioritize reducing the emission of criteria pollutants in areas where they have been historically prevalent.

How much do fees on gasoline cost drivers?

Today, many EVs may have a higher upfront cost than a comparable ICE vehicle. However, EVs are typically less costly to fuel than comparable ICE vehicles. For example, we estimate that a new passenger ICE vehicle purchased in New York in 2018 would require about $90 per month in gasoline expenditures while a comparable EV would cost about $50 per month in electricity purchases. In our Electrification Only scenario, we estimate that in 2035 a new ICE passenger car would require about $115 of gasoline per month. Meanwhile, the electricity to charge a comparable new EV would cost just $45 per month.

In both policy cases, we assume new fees on polluters are established to incentivize a shift toward cleaner vehicles. These fees, totaling about $14 per month per ICE vehicle by 2035, could be part of any number of mechanisms. Here, they are modeled in part based on estimates from modeling New York's participation in the TCI. Funds raised from these incremental fees could accelerate the clean energy transition by supporting EV rebates or "Cash for Clunkers" programs, construction of charging stations, or improving bicycle, pedestrian, and public transit infrastructure.

Second, revenue from pollution fees can be used to improve transportation equity for disadvantaged communities. Large and sudden increases to pollution fees could hurt those with an older, inefficient vehicle and limited means to purchase a new, cleaner EV. Revenue from these fees could fund improved transit service and infrastructure, construction of charging infrastructure in disadvantaged communities, construction of affordable housing in walkable and transit-oriented locations, or subsidized electric car-sharing access to supplement transit for low-income households. In addition, policies like California's Enhanced Fleet Modernization Program (EFMP)—a scrap-and-replace program similar to the federal "Cash For Clunkers" program—provide increasing rebates for lower-income drivers and remove the dirtiest vehicles from the road earlier than they might otherwise retire.[28] Such programs may be especially important for New York's rural communities, where low-carbon transportation alternatives may be more costly or face political obstacles.

Furthermore, 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 CO_2 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.

Under the CLCPA, disadvantaged communities are required to receive 35-40% or more of the overall benefits of spending on projects or investments, including transportation projects. Policy decisions, including those determining where CLCPA-related projects will be implemented, should be made by engaging residents early and often to identify priorities and shape plans. The CLCPA also requires that New York create a new "community air monitoring program" that will track progress on diminishing local air pollution. Under this program, the Climate Justice Working Group established by the CLCPA must identify high-risk communities, monitor air quality in these communities for exposure to pollutants from transportation and other sources, and create and implement strategies to improve air quality. These programs can help ensure that policies aimed at achieving significant reductions in emissions are also producing co-benefits for health and equity.

Other potential policy levers

This report highlights several policy levers available to New York, but the set of policies analyzed here is by no means exhaustive. We have modeled our two scenarios based on expansions of policies that are already in use or under design in the state. Instead of implementing this specific policy portfolio, New York could choose a combination of these with other similarly or more aggressive and comprehensive policies. Several other alternatives could include:

ICE vehicle or all-vehicle exclusion zones (highway lanes, city and town centers, etc.): Exclusion zones can reduce the local air pollution in populated urban environments, where pollution impacts the largest numbers of people. These zones have the added benefit of encouraging EVs (or active transportation) by allowing them to travel in a wider range of locations. In some situations, such zones could be created through the use of congestion pricing or HOV lane access for EVs.

Incentives to retire dirty vehicles early: Another category of programs aims to take the oldest and dirtiest vehicles off the road. These "scrap-and-replace" policies, such as the federal Cash for Clunkers program or California's Enhanced Fleet Modernization Program (EFMP), pay drivers to scrap their old and inefficient vehicles.

Reduced tolls for EVs: Reducing fees for EVs makes owning an EV more useful and less costly. Policies could include reducing tolls or registration fees for EVs.

Moving toward EVs is essential

Moving toward EVs is essential, even if New York pursues policies to reduce the total amount of miles driven in the state. Policies that reduce VMT by 5% each decade can reduce the need for 360,000 electric LDVs, as compared to a scenario where those same VMT reductions are not realized. However, even in the Electrification with Mode Shifting scenario, to be on track to reduce emissions 55% by 2035, two million more electric LDVs must be on the road in 2035 than in the BAU. To reach that number, New York will need aggressive policies to promote EV adoption, because there will still likely be too much driving in 2035 to ignore the need for a near-total electrification of new vehicle sales.

Moreover, New York needs to electrify beyond LDVs. Today, 20% of motor vehicle CO_2 emissions in New York come from MDVs, HDVs, or buses. With the exceptions of buses and urban delivery vans, electrification of these vehicle categories has been largely unexplored. While some of the vehicles in this category would be challenging to decarbonize with today's EV technology, others are prime candidates for electrification. This includes delivery and municipal trucks that have regular, predictable routes and can benefit from the substantial torque provided by electric motors. Furthermore, half of New York's buses, 31% of its heavy-duty single vehicles, and 13% of its MDVs are municipally owned. This presents an opportunity for state and municipal governments to achieve vehicle electrification via procurements and mandates.

Conclusions

Our analysis finds that by decreasing motor vehicle emissions by 55% in 2035 and by enacting a suite of familiar and implementable policies, New York can ensure its transportation sector is on track to meet economy-wide GHG reduction goals. 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 a 55% by 2035 goal, New York cannot delay in adopting policies that will encourage EV adoption and decrease reliance on personal vehicles. By reducing the upfront costs and widening ongoing cost savings of EVs relative to ICE vehicles, eliminating range anxiety by facilitating deployment of public charging infrastructure, expanding transportation options, and implementing pricing mechanisms that reflect the true cost of fossil fuels, New York can lead the charge to clean up America's transportation sector.

Endnotes

1 See https://www.nyserda.ny.gov/-/media/Files/EDPPP/Energy-Prices/Energy-Statistics/greenhouse-gas-inventory.pdf.

2 See https://www.dec.ny.gov/energy/94702.html.

3 See https://nyassembly.gov/leg/?default_fld=&leg_video=&bn=A08429&term=2019&Summary=Y&Actions=Y&Text=Y.

4 Under the CLCPA, the state must reduce economy-wide emissions by 85% by 2050. The remaining 15% of emissions can either be directly reduced or offset through other mechanisms that remove greenhouse gases from the atmosphere.

5 See https://www.nysenate.gov/legislation/bills/2019/s6599.

6 Comments from Andy Byford at April 25, 2018 MTA Board Meeting, available at https://www.youtube.com/watch?v=3u2Z35Awh84, at 1:17:00. Also see MTA Bus Plan. April 2018. Available at http://web.mta.info/nyct/service/bus_plan/bus_plan.pdf.

7 See Rochester Genesee Regional Transportation Authority Board of Commissioners Quarterly Meeting Minutes, December 2018: https://www.myrts.com/Portals/0/Documents/Board/Board%20Meeting%

20Minutes/December%202018%20Quarterly%20Board%20Meeting%20Minutes.pdf?ver=2019-01-16-132026-617.

8 See https://www.nypa.gov/innovation/programs/evolveny.

9 More information about the Charge Ready NY program is available at https://www.nyserda.ny.gov/All-Programs/Programs/ChargeNY/Charge-Electric/Charging-Station-Programs/Charge-Ready-NY.

10 See https://www.tax.ny.gov/pit/credits/alt_fuels_elec_vehicles.htm.

11 The Clean Air Act allows California to set its own "standards relating to control of emissions from new motor vehicles" that differ from those of the federal government, and Section 177 allows other states to follow California's regulations. More information about the ZEV regulation is available on the California Air Resources Board's website at https://ww2.arb.ca.gov/our-work/programs/zero-emission-vehicle-program/about. The text of the Clean Air Act is available on the EPA's website at https://www.epa.gov/clean-air-act-overview/clean-air-act-title-i-air-pollution-prevention-and-control-parts-through-d#id.

12 Our nationwide business-as-usual projections of the EV share of sales for LDVs are largely consistent with recent projections from other organizations, including BNEF (https://about.bnef.com/electric-vehicle-outlook/) and DNV GL (https://eto.dnvgl.com/2018/), through the early 2030s. Because New York is among the states with more advanced levels of EV sales and EV policies today, it typically sees levels of EV sales that are higher than the national average.

13 The percentages described in these sensitivities vary in each year. In addition, they do not sum to 100% as these policies can have overlapping effect when it comes to lifetime vehicle cost and vehicle desirability.

14 The Transportation and Climate Initiative (TCI) is a regional effort of 12 states in the Northeast and Mid-Atlantic states to reduce carbon emissions from the transportation sector. See https://www.transportationandclimate.org/ for more information.

15 The Federal Highway Administration's describes road diets at https://safety.fhwa.dot.gov/road_diets/.

16 The ZEV Task Force's Multi-State ZEV Action Plan 2018-2021 discusses the need for charging opportunities at "home, work, around town, at destination locations and on the road." See https://www.nescaum.org/topics/zero-emission-vehicles for more information.

17 These values correspond to the Nissan Leaf (160 miles of range per 50 kWh) and Tesla Model 3 (197 miles of range per 50 kWh.) The Chevrolet Bolt EV falls between these vehicles at 177 miles of range per 50 kWh. Data is from the EPA and can be found at https://www.fueleconomy.gov/feg/Find.do?action=sbs&id=41416&id=40520&id=40812&id=41276.

18 See https://www.nyiso.com/documents/20142/2226333/2019-Gold-Book-Final-Public.pdf/a3e8d99f-7164-2b24-e81d-b2c245f67904?t=1556215322968, Table I-1b.

19 Current data on counties in nonattainment under the 2015 ozone NAAQS can be found at https://www3.epa.gov/airquality/greenbook/jbcs.html#NY; population values calculated using 2018 population estimates from https://data.ny.gov/Government-Finance/Annual-Population-Estimates-for-New-York-State-and/krt9-ym2k/data.

20 Environmental Protection Agency, "Smog, Soot, and Other Air Pollution from Transportation", 2014, https://www.epa.gov/transportation-air-pollution-and-climate-change/smog-soot-and-local-air-pollution.

21 New York State, "Asthma Surveillance Summary Report", p. 31-32, Oct. 2013, https://www.health.ny.gov/statistics/ny_asthma/pdf/2013_asthma_surveillance_summary_report.pdf.

22 U.S. EPA's CO-Benefits Risk Assessment Health Impacts

Screening and Mapping Tool (COBRA) examines changes in criteria pollutant emissions by sector, estimates air dispersion and demographic data, and returns values in terms of incidence rates of health impacts as well as monetized benefits (e.g., direct medical and societal costs associated with these health impacts). Health benefits are calculated for the nation as a whole. See https://www.epa.gov/statelocalenergy/co-benefits-risk-assessment-cobra-health-impacts-screening-and-mapping-tool for more information.

23 See https://www.eia.gov/state/seds/.

24 These avoided fuel expenditures are calculated based on the projection of regionally specific gasoline and diesel prices in the 2019 Annual Energy Outlook (AEO), and do not take into account changes to prices that may occur with falling demand, or avoided costs associated with new pollution fees.

25 Although new car owners may only own their new vehicle for several years, when re-sold as used, these vehicles may persist in the fleet for decades.

26 See https://www.ucsusa.org/sites/default/files/attach/2019/06/Inequitable-Exposure-to-Vehicle-Pollution-NY.pdf .

27 Perera FP. 2017. Multiple threats to child health from fossil fuel combustion: impacts of air pollution and climate change. Environ Health Perspect 125:141–148; http://dx.doi.org/10.1289/EHP299.

28 See https://ww3.arb.ca.gov/msprog/aqip/ldv_pilots/efmp_plus_up_faq.pdf.

Synapse Energy Economics

Synapse Energy Economics, Inc. is a research and consulting firm specializing in energy, economic, and environmental topics. Since its inception in 1996, Synapse has grown to become a leader in providing rigorous analysis of the electric power sector for public interest and governmental clients. Synapse's staff includes experts on a variety of energy and environmental economics, including resource planning, electricity dispatch and economic modeling, energy efficiency, renewable energy, and sustainable transportation.

For more information, contact:

Pat Knight | pknight@synapse-energy.com | 617-453-7051
Jason Frost | jfrost@synapse-energy.com | 617-453-7043

Sierra Club

The Sierra Club is America's largest and most influential grassroots environmental organization, with more than 3.5 million members and supporters. In addition to protecting every person's right to get outdoors and access the healing power of nature, the Sierra Club works to promote clean energy, safeguard the health of our communities, protect wildlife, and preserve our remaining wild places through grassroots activism, public education, lobbying, and legal action.

For more information, contact:

Allison Considine, NY Campaign Representative, Sierra Club
allison.considine@sierraclub.org | 585-730-2127

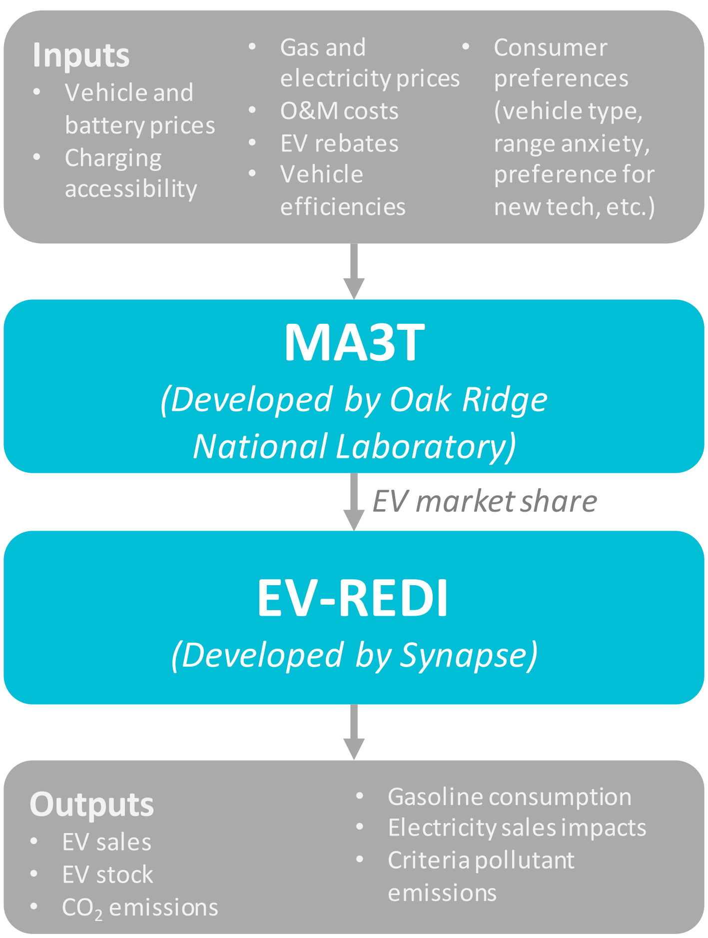
APPENDIX

The following appendix provides greater detail on the methodology and inputs used to conduct the analysis described in *Transforming Transportation in New York: Roadmaps to a 2035 Transportation Climate Target*.

Methodology Detail

We performed our analysis using two models: the Market Acceptance of Advanced Automotive Technologies (MA3T) model and the Electric Vehicle Regional Emissions and Demand Impacts (EV-REDI) model. We used MA3T to assess the annual impacts of technology changes and transportation sector policies on the share of EVs relative to total LDVs and EV-REDI to translate these share-of-sales into vehicles on the road, CO_2 emissions, and other outputs (see Figure 8).

Figure 7. Modeling methodology schematic



About MA3T

MA3T was developed by Oak Ridge National Laboratory (ORNL) and most recently updated in April 2019. It is available for free download (see https://teem.ornl.gov/ma3t.shtml). MA3T is a consumer adoption model, which means that it predicts the types of LDVs customers are likely to purchase based on a set of inputs, including vehicle price, fuel prices, operating and maintenance costs, financial incentives, the convenience of charging, and vehicle range. The assumptions address consumer characteristics, including sensitivity to price, range anxiety, and preference for new technologies. MA3T contains segmented data for all 50 states and Washington D.C.; it also contains dozens of vehicle segments for different types of LDVs and powertrains.

ORNL's 2019 update to MA3T contains the latest information on fuel prices, consumer preferences, and historical EV sales. Synapse calibrated nationwide sales of EVs in the Business-as-Usual scenario in MA3T to the 2018 Bloomberg New Energy Finance EV Outlook projection (see https://about.bnef.com/electric-vehicle-outlook/).

About EV-REDI

EV-REDI was developed by Synapse and deployed in September 2018 (see https://www.synapse-energy.com/tools/ev-redi). EV-REDI is a stock turnover and scenario analysis model. It combines a user-specified trajectory of EV sales and combines this with state-specific data including 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.

Modeling caveats

This analysis can be thought of as a "what if" analysis: it posits a set of policies that are likely to encourage growth in EV sales share and examines the impacts on the number of vehicles on the road, reduced emissions, and other outputs. It is not an examination of the only pathways to decarbonization or a least-cost pathway. As with all models that examine different potential futures, its projections are likely most accurate for near-term years, with projections becoming more uncertain for years far into the future.

MA3T is a consumer adoption model for LDVs only; it does not consider impacts on medium-duty vehicles, heavy-duty vehicles, or buses. To model the impact of these vehicles on tailpipe emissions, Synapse developed a set of three categories of sales adoption: (1) under the "fast" trajectory, EV adoption increases to 100% of new non-LDV vehicle sales in 2025; (2) under the "medium" trajectory, non-LDV vehicles follow an EV adoption curve that lags 4 years behind the LDV trajectory; and (3) under the "slow" trajectory, non-LDV vehicles follow an EV adoption curve that is the same as the LDV trajectory but with a 10-year lag (see Table 5 for more detail). These trajectories are linked to the LDV trajectory estimated under each modeled scenario, and thus are different across scenarios.

Vehicle classifications

A light-duty vehicle or LDV is any vehicle that weighs less than 10,000 lbs. Broadly speaking, this includes any passenger car or truck that might be purchased for daily personal use. This category includes SUVs, small and medium pickup trucks, as well as sedans and other passenger cars.

Other motor vehicles are not so consistently categorized. For the purposes of this analysis, medium-duty vehicles are vehicles that weigh more than 10,000 lbs but less than 26,000 lbs. This category includes larger pickup trucks, work vans, tractors, and delivery vehicles. Heavy-duty vehicles are any vehicle weighing more than 26,000 lbs. For the purposes of this analysis, this category includes three subcategories: buses, heavy-duty (single) vehicles, and heavy-duty (combination) vehicles. Everyday examples of heavy-duty (single) vehicles are dump trucks, flatbed trucks, and garbage or refuse trucks; these consist of "single" integrated cab and cargo components.

Conversely, heavy-duty (combination) vehicles may have their cab and cargo components detached. This category largely consists of tractor trailer or semi vehicles. The heavy-duty (combination) vehicles have large overlap with long-haul deliveries, whereas short-haul deliveries are split between the medium-duty and heavy-duty (single) categories.

Table 5. Electrification trajectories for non-LDVs

Vehicle category	Assumed electrification trajectory
Buses	
Total Private	
Private Buses	slow
Total Public	
Municipally-owned buses	BAU: medium, Policy cases: fast
Other gov't-owned buses	BAU: medium, Policy cases: fast
Medium-duty vehicles	
Total Private	
Privately-owned delivery trucks	medium
Privately-owned tractors	slow
Privately-owned "utility" vehicles (Ford F-350 or larger)	medium
Privately-owned tow trucks	slow
Other privately-owned MDVs	slow
Total Public	
Municipally-owned "utility" vehicles	medium
Other gov't-owned MDVs	slow
Heavy-duty vehicles (single)	
Total Private	
Private dump trucks	slow
Private flatbed trucks	slow
Private tank trucks	slow
Other privately-owned single HDVs	slow
Total Public	
Municipally-owned dump trucks	medium
Other gov't-owned vehicles	slow
Heavy-duty vehicles (combination)	
Total Private	
Privately-owned semi	slow
RVs	slow
Other privately-owned vehicles	slow
Total Public	
Other gov't-owned vehicles	slow

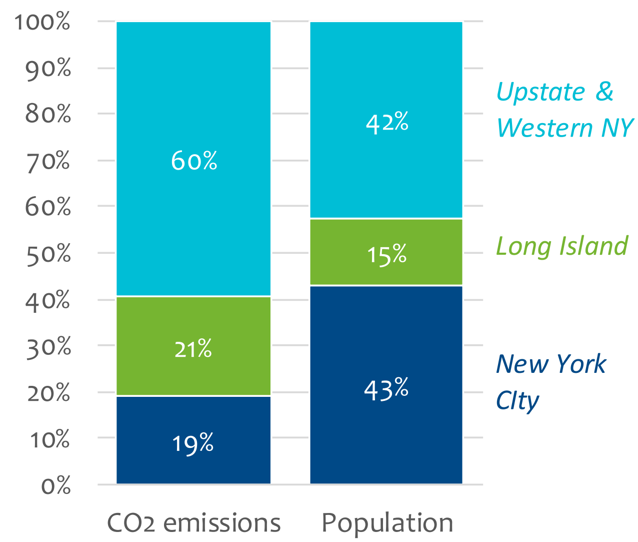
VMT Reductions

New York's network of densely-populated, transit-oriented communities—both in the New York City metro and Upstate—offers it an unparalleled opportunity to reduce vehicle miles traveled (VMT). Figure 9 demonstrates how densely-populated counties have relatively low CO_2 emissions despite having large populations. In particular, New York City features 43% of the state's population, but encompasses just one-fifth of motor vehicle-based CO_2 emissions. While VMT reductions may be challenging to achieve in certain situations, studies in the literature suggest that a combined set of policies that encourage pedestrian and biking infrastructure, public transportation, and transit-oriented development can achieve VMT reductions on the order of 5% per decade (see Table 6).

Table 6. Impact of VMT reductions in the literature

Reference	Selected findings
Smart Growth America, *Driving Down VMT* (2016)	Pedestrian and bike friendly streets can reduce VMT by 5-10%, improved transit frequency and new corridors can reduce VMT by 1-2%, and road-pricing can achieve 1-3% VMT reductions.
Bento, Cropper, Mobarak, and Vinha (2003 & 2005)	The elasticity of VMT was found to be -0.18 with respect to population centrality, -0.04 with respect to supply of rail transit, and 0.09 with respect to distance to nearest transit stop.
Salon, Boarnet, and Mokhtarian (2014)	VMT elasticities were found to be as large as -0.2 with respect to changes in regional and local jobs access and gasoline price.
Transportation Research Board, *Driving and the Built Environment* (2009)	Increasing all built environment variables (such as density and land use diversity) by 100% was estimated to reduce VMT by 13-25%.

Figure 8. Estimated share of motor vehicle CO_2 emissions and population by region



CAFE Standards

Efficiency standards have played an important role in increasing average fleet fuel efficiency in the U.S. Looking ahead, there is room for improvement in ICE fuel efficiency. However, the much greater efficiency of EVs (measured in miles per gallon equivalent) has the potential to increase fleet average fuel efficiency without improving ICE efficiency, depending on how EVs are incorporated into fleet average fuel economy calculations. This means that future fuel economy standards as currently written may be met by simply increasing the number of EVs sold instead of improving ICE efficiency. As the Trump administration seeks to repeal Obama-era fuel efficiency standards and revoke California's right to set its own efficiency standards, there is also a lot of uncertainty about how stringent fuel efficiency standards will be in the coming years.

For these reasons, the fuel efficiency improvement trajectory used in this report assumes a slow rate of improvement that might occur under the Trump administration's proposed CAFE standard rollbacks. There is considerable uncertainty about whether New York's standards, which are tied to California's, will ultimately change. As a sensitivity, we evaluated the impact of a more quickly improving fuel trajectory on the BAU, specifically one based on the EIA's projection of how quickly fuel efficiency will improve if today's CAFE standards remain in effect.

In this sensitivity, motor vehicles emit 32 million metric tons (MMT) CO_2 in 2035, compared to 37 MMT CO_2 emitted in 2035 in the BAU scenario. The reduction in emissions can be attributed to two factors. With greater improvements in fuel efficiency, we project ICE costs to increase, which leads to more EV sales. Additionally, emissions are lower due to the increased fuel efficiency of the remaining ICE vehicles. This sensitivity serves as a lower bound on CO_2 emissions in a business-as-usual scenario.