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NEW YORK CITY ENVIRONMENTAL JUSTICE ALLIANCE

Prioritizing Justice in New York State Cap-Trade-and-Invest

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Resources for the Future (RFF) is an independent, nonprofit research institution in Washington, DC. Its mission is to improve environmental, energy, and natural resource decisions through impartial economic research and policy engagement. RFF is committed to being the most widely trusted source of research insights and policy solutions leading to a healthy environment and a thriving economy.

About NYC-EJA

The New York City Environmental Justice Alliance (NYC-EJA) is a non-profit, 501(c)3 citywide membership network linking grassroots organizations from low-income neighborhoods and communities of color in their struggle for environmental justice. NYC-EJA empowers its member organizations to advocate for improved environmental conditions and against inequitable environmental burdens by the coordination of campaigns designed to inform City and State policies.

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1. Introduction

New York State is currently planning for and implementing the New York Climate Leadership and Community Protection Act (CLCPA), which was passed in 2019 to promote renewable energy and battery storage, transportation electrification, building decarbonization, and climate resiliency and adaptation. The CLCPA directs the state to reduce statewide greenhouse gas (GHG) emissions by 40 percent by 2030 and 85 percent by 2050 (relative to 1990 levels)—and to achieve net-zero GHG emissions economy-wide. In meeting these targets, the state must prevent disproportionate burdens on disadvantaged communities (DACs) and prioritize GHG and copollutant reductions in DACs as defined by the Climate Justice Working Group. Additionally, Section 0117 of Article 75 of the Environmental Conservation Law, an environmental justice (EJ) provision of the CLCPA, requires that DACs receive at least 35 to 40 percent of climate investments and benefits.

The CLCPA established the Climate Action Council to develop a framework for how the state could meet the CLCPA goals and commitments. In January 2023, the Council released its final Scoping Plan, which outlined strategies to achieve the GHG and net-zero emissions targets and increase renewable energy usage. A cap-trade-and-invest program was among the strategies identified as a tool that could help the state hit its emissions targets and generate revenue for climate action and investments. The New York State cap-trade-and-invest program is intended to encourage decarbonization by capping carbon emissions, requiring emitters to purchase allowances to emit, and subsidizing (the "invest" side) the adoption of low-carbon technologies such as heat pumps.

Since early 2023, the governor and state have announced and focused on a cap-trade-and-invest program ("NYCI") as a priority measure to reduce GHG emissions economy-wide.[1] Draft cap-trade-and-invest regulations are expected to be released by the Department of Environmental Conservation (DEC) and New York State Energy Research and Development Authority (NYSERDA) in mid-2024, with a public hearing and comment period to follow. As currently described by state agencies, cap-trade-and-invest will establish an auction for emissions allowances and allow entities to freely trade allowances in a secondary market, as in the economy-wide carbon cap-and-trade systems of California, Washington State, and the European Union (NYSERDA and DEC 2023). However, New York State's cap-trade-and-invest must additionally meet the CLCPA's explicit requirement to not disproportionately burden DACs and to prioritize emissions reductions in them. The preproposal released by NYSERDA and DEC in December 2023 offered some ideas about how the program might ensure benefits for DACs and highlighted its willingness to consider implementing facility-specific caps outside the cap-trade-and-invest program. The preproposal indicates that the caps would be administered separately under DEC and that the state is seeking additional guidance on how these caps might be implemented (NYSERDA and DEC 2023).

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[1] The state has named it the New York Cap-and-Invest or NYCI, however, regulatory agencies have expressed that there will be a form of trading so we refer to it as cap-trade-and invest to be clear about the program.

Our research analyzes the emissions effects of different cap-trade-and-invest policy designs at the statewide and community level[2] in New York. The first policy design is a traditional cap-and-trade program with full trading allowed between sectors and with no facility-specific restrictions (the full trading case, or FTC). Because of modeling constraints, we were unable to model a case with carbon allowances that can't be traded in a secondary market[3], so the second case restricts trading through facility- and sector-specific caps designed to prioritize emissions reductions in DACs and limit their pollution burden (the restricted trading case, or RTC). Both the FTC and RTC obligate the power sector and are designed with caps that assume achievement of the 40 by '30 target mentioned above[4, 5]. Our analysis assesses the two policy designs and compares them with a business-as-usual (BAU) policy case where no economy-wide carbon pricing or trading policy is implemented.

In this report, we provide GHG and copollutant emissions (fine particulate matter, $PM_{2.5}$; nitrogen oxides, NO_x; and sulfur dioxide, SO_2) results, along with a variety of economic metrics. Air quality results, along with an additional policy case, will be forthcoming in a separate issue brief. In that analysis, we leverage a model that considers how direct emissions covered in this report combine, migrate, and settle into $PM_{2.5}$ concentrations at the census tract level. The initial emissions analysis presented in this first report provides key insights on direct pollutants, particularly in the power sector, where our model provides detailed data at the latitude-longitude level about the proximity of copollutant emissions to DACs.

Our analysis has revealed several insights:

1. A cap-trade-and-invest program reduces carbon emissions in all modeled sectors beyond the baseline policies included in the BAU. Implementing either modeled cap-trade-and-invest system (FTC or RTC) yields an approximately 22 percent reduction in emissions from the BAU statewide in 2030.
2. At facilities within one mile of a DAC, facility-specific caps (RTC) increase the average facility direct $PM_{2.5}$ emissions reductions (from 2016) by nine percentage points, from 80 to 89 percent, compared with a scenario with a cap-trade-and-invest program that doesn't include facility-specific caps. SO_2 and NO_X emissions behave similarly.

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[2] Communities are defined by census tracts in this analysis.

[3] Our modeling reflects a system with a free market for allowances because obligated entities will only pay up to their marginal cost of carbon abatement for a carbon allowance. In a system without a secondary market, entities may behave differently, or some allowances may end up stranded with obligated entities that cannot use them or sell them. We cannot capture these behaviors in our models.

[4] We do not model all sectors, so we establish an emissions budget for the modeled sectors estimated to reflect economywide reductions under the 40 by '30 target (40 percent below 1990 levels by 2030). See Appendix E for more detail.

[5] The preproposal analysis released by the state signaled that the electricity sector may not be obligated to purchase allowances in New York state cap-trade-and-invest program but would be covered by the Regional Greenhouse Gas Initiative. We discuss how that policy may impact the interpretation of our results in the conclusion.

3. The facility-specific caps included in the RTC reduce New York direct $PM_{2.5}$ emissions within a mile from DACs on net by over 44,000 tons in 2030 (with significant reductions in SO_2 and NO_x emissions). The caps have virtually no impact on retail electricity prices.
4. Sector-specific caps (RTC) that force greater emissions reductions in specific sectors reduce GHG emissions by 4 percent more in the residential sector (or 0.76 MMT CO_2e) relative to a cap-trade-and-invest program with full trading across sectors (FTC).
5. Sector-specific caps (RTC) that require fewer GHG emissions reductions in the transportation and power sectors lead to lower gasoline and residential electricity prices relative to a cap-trade-and-invest program with no sector-specific caps (FTC). Prices are lower by 10 cents per gallon and 30 cents per MWh respectively. The increase in average household heating costs is outweighed by the reduction in average household transportation costs.

Our research demonstrates that cap-trade-and-invest policy design choices can affect the distribution and cost of GHG emissions reductions. Including facility-specific caps can ensure a minimum level of reductions for each facility without driving costs significantly higher, compared with not having facility-specific caps. Additionally, sector-specific caps with no trading between sectors can help ensure a minimum level of reductions in each sector while mitigating some important household costs. Our cost findings reflect the assumption that New York State will make generous investments in electrification subsidies for households. The details of a cap-trade-and-invest program, such as those we model, will determine whether New York State simultaneously achieves its GHG emissions goals, prevents disproportionate burdens in DACs from conventional pollution emissions and concentrations, and produces revenue that can sustain and drive climate action and investments by the state. For EJ stakeholders, this research is essential because they will not support a cap-trade-and-invest system that may further harm the health and quality of life for low-income communities and communities of color, which could violate Section 7(3) of the CLCPA.

2. Relevant Research

Cap-and-trade policies, like carbon taxes, are often favored by economists because they create a price signal for emissions reductions. Through market mechanisms, low-cost carbon abatement options can be identified and adopted instead of high-cost abatement options. However, economy-wide carbon pricing policies (either cap-trade-and-invest or carbon taxes) do not equally protect all communities from the harmful impacts of polluting industries unless additional constraints are imposed. If sectors or businesses are particularly expensive to decarbonize, they will likely continue to pay the price for carbon emissions rather than reduce their polluting behavior. Moreover, if these businesses or other polluters are disproportionally located in DACs, some communities could face higher pollution burdens with a cap-trade-and-invest program in place.

Prior to release of the Climate Action Council's Scoping Plan, some environmental and climate justice advocacy groups were calling for adoption of the Climate Community Investment Act (CCIA) over a cap-trade-and-invest system. The CCIA was a polluter fee policy that priced not only GHG emissions but also harmful copollutant emissions, based on the relative harm they posed to society (also referred to as their social cost). Revenue from the CCIA program would be intentionally invested to advance a just transition to a clean, renewable energy economy for New York State. The CCIA would have created a dedicated Climate and Community Investment Authority to administer a multi-billion-dollar program that included worker protections, investments in renewable energy, emissions reduction, infrastructure, and community-led projects across the state. Another important component of the CCIA was the Community Directed Grant Program to provide direct support to community- and constituency-based organizations, unions, and local governments, rooted in and led by DACs to further energy and resiliency planning through community-led initiatives.

Some of the consulted stakeholders, including environmental justice groups, remain skeptical that a cap-trade-and-invest system will enable New York State to hit its emissions targets and equitably distribute air quality benefits to communities of color and low-income communities (NY Renews 2023). For example, in California, the state's Legislative Analyst's Office's analysis of California's 2022 Scoping Plan Update concluded that California was not on track to meet its 2030 goals through cap-and-trade: "the program is not stringent enough … it will not drive the additional emission reductions needed to close a 2030 emissions gap. One key reason for this is because there will be more than enough allowances available for covered entities to continue to emit at levels exceeding the 2030 target" (Petek 2023). The California program allows unlimited banking of allowances from earlier years, which can then be used to comply with more strict caps in later years (Taylor 2017). Furthermore, many jurisdictions allow polluters to purchase offsets instead of allowances, which, to the extent they deliver additional emissions reductions, may provide no benefit to the community exposed to pollution. Many other aspects of these existing systems designed to reduce costs, such as free allocation to industrial polluters, border adjustments for exports, and allowance trading, can create negative, unintended effects for communities of color and low-income communities (Plummer et al. 2022; Pastor et al. 2022).

Additionally, some research raises concerns about cap-trade-and-invest programs and their impacts on DACs. Pastor et al. (2022) find that emissions at facilities near DACs have not improved at the same rate as facilities in wealthier communities under cap-and-trade in California. In fact, the research team finds that facilities near DACs often increase pollution under the policy (Pastor et al. 2022). A California state-sponsored study released in 2022 shows that some sectors, including oil refineries and cement plants, increased emissions (e.g., GHGs and $PM_{2.5}$) under cap-and-trade (Plummer et al. 2022). A 2016 USC study that assessed the EJ impacts during the first compliance period (2013–14) found that although overall GHG emissions in California dropped from a peak in 2001, many industrial sectors covered under cap-and-trade reported increases in localized in-state GHG emissions after the program came into effect in 2013 (Cushing et al. 2016). The USC team updated the 2016 study and found that DACs saw some improvements in terms of reduced pollutants from cap-and-trade facilities, but these improvements were less than those in the non-DACs (Pastor et al. 2022).

On the other hand, research by Hernandez-Cortes and Meng (2023), comparing cap-and-trade with an alternative scenario without the policy, estimates that the program has made progress toward closing the air quality gap between disadvantaged and advantaged communities in California. Burtraw and Roy (2023) find that although most facilities near DACs in California have kept pace with the statewide emissions reductions (because of a mix of regulatory policies and the cap-and-trade program), outliers continue to pollute at elevated levels near DACs with high population density. Their work further indicates that facility-specific caps could improve outcomes for these communities at a relatively low cost.

Environmental justice advocates prefer direct emissions reduction measures, such as stronger vehicle standards and whole-home retrofits, over market-based solutions that let polluters pay to pollute. Community advocates who have worked hard to pass the CLCPA and ensure that DACs are not disproportionately burdened by pollution and its harmful health impacts fear that a cap-and-trade system will produce the same outcomes of many previous government decisions that rely on market-based solutions, namely that wealthy communities will benefit while historically underserved and disinvested communities get left behind. Environmental justice advocates consulted in this work will support a cap-trade-and-invest program only if it addresses the historical pattern of air pollution, sickness, and environmental degradation forced on communities of color and low-income communities.

A cap-trade-and-invest system that doesn't explicitly consider these issues could further perpetuate the cycle of disparities in which the benefits of policies and investments are realized by wealthy communities at the expense of communities of color and low-income communities that continue to face disproportionate pollution burdens. To prevent these outcomes, EJ advocates have identified policy safeguards or "guardrails" to include in a cap-trade-and-invest program that would prevent pollution hotspots and ensure equitable air quality improvements and benefits for DACs. These guardrails include sector- and facility-specific caps, strict limits on banking and borrowing, and prohibitions on allowance trading, allowance offsets, and free allocations.[6] This analysis explores some of these policy guardrails to investigate their effects on emissions, local air quality, and costs.

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[6] Many EJ stakeholders oppose trading altogether, preferring an administratively set price or a system in which all allowances must be purchased directly from the state at a market price (without a secondary trading market). We were unable to model this exact framework, so we focused on other important restrictions on trading that New York State might consider.

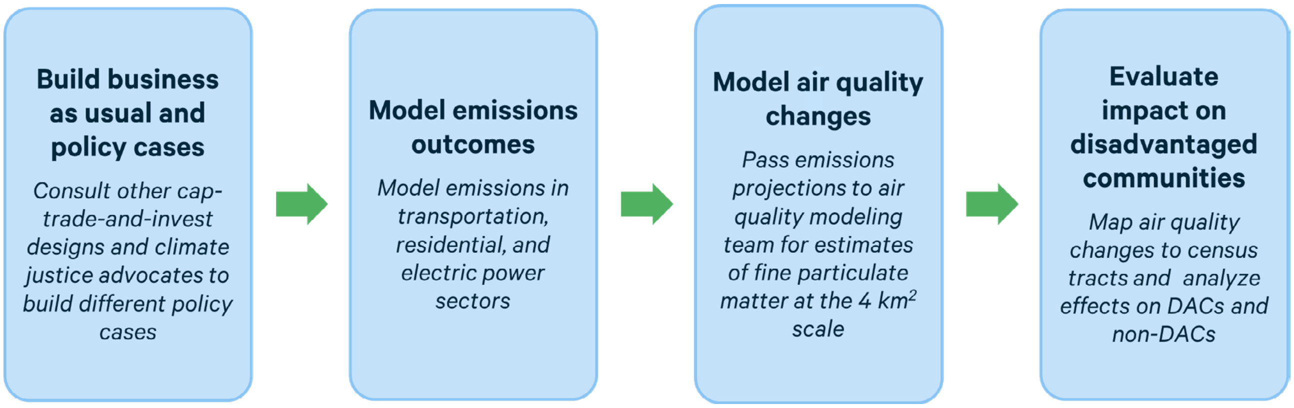
3. Methodology

This work represents the next phase of research established to analyze the EJ effects of CLCPA implementation. Our first report (Krupnick et al. 2023) looks broadly at program ambition in the context of CLCPA implementation and how more aggressive decarbonization policies prioritizing DACs can influence the air quality in these communities. This next iteration looks specifically at how various cap-trade-and-invest program designs affect costs, emissions, and pollution. The collaboration and research involve several models that build on each other to estimate the emissions and air quality effects of different policies.

The first step in our research is to build and compare three policy cases: a business-as-usual case, a traditional cap-trade-and-invest with full trading, and a cap-trade-and-invest with restricted trading and specific caps. We use four economic models that estimate the 2030 emission levels resulting from the different policies in each of the three cases (see Appendix A). Our Analysis includes the following sectors: electric power, light-duty vehicle market and fleet, medium- and heavy-duty vehicle market and fleet, nonmarine port activities and residential buildings.

Our research collaboration will offer unique insights on air quality and community-level effects in a forthcoming report. In combination with the economic and behavioral models mentioned above, we use one of the most sophisticated air quality models available to assess and trace the community-level air quality outcomes of the policy cases, comparing DACs and non-DACs (see Appendix B for a description of the methodology for identifying these communities). Furthermore, visually mapping these results at the 4km^2 scale will give readers the ability to assess and understand the geographic distribution of results and how they relate to DACs in New York State. We will cover these air quality results in a subsequent report. In this report, we focus on emissions of GHGs, NO_X, SO_2, and direct $PM_{2.5}$. Figure 1 depicts the flow of the research process for this project.

Figure 1. Research Process



The findings from this project contribute to the body of work investigating the effects of the state's climate policies (Krupnick 2023; E3 2022). We also acknowledge that two important limitations to our research may influence the interpretation of the results. First, our model is not a general equilibrium model designed to identify the price of carbon allowances in the economy. Our models have a good representation of each sector's responsiveness to carbon prices, but our work is not intended to estimate the price in the state's cap-trade-and-invest program. Second, we do not include the industrial sector in our model because our team lacks the modeling capabilities to investigate location-specific emissions reductions in this sector. We do, however, want to note that how the industrial sector is treated in the cap-trade-and-invest system is an important EJ consideration.

4. Policy Cases

We model and provide findings for the following three policy cases: (1) business-as-usual, (2) traditional cap-trade-and-invest with full trading, and (3) cap-trade-and-invest with restricted trading and specific caps on sectors and facilities. Both cap-trade-and-invest designs include generous electrification subsidies and other complementary policies to represent the "invest" aspect of the proposal in a simplified way (see Appendix F for a complete list). We focus on 2030 as the year for modeling economic activity and related air pollutant concentrations throughout New York State. Again, each cap-trade-and-invest case is designed to achieve the greenhouse gas target of 40 percent reductions from 1990 levels by 2030, as discussed further below and in Appendix E.

Our modeling begins with a **business-as-usual (BAU) case**, which includes the following: policies in place prior to the passage of the CLCPA; federal policies like the Inflation Reduction Act (IRA) and the Infrastructure Investment and Jobs Act (IIJA); and policies passed and implemented because of the CLCPA.[7] The BAU leverages baseline assumptions on fuel prices, population growth, and income changes as estimated by the Energy Information Administration (EIA) in the 2021 Annual Energy Outlook.[8] EIA limits its modeling to sets of policies (mostly federal but in some cases state) that are already in place, excluding policies that might be implemented in the future.

The next case we model is the **full trading case (FTC)**, which reflects a traditional cap-trade-and-invest policy design without mandatory emissions reductions for specific facilities and sectors. The FTC also includes spending from the "invest" side of the policy, with subsidies for heat pumps, EVs, and fossil fuel phase outs in the building sector (see Appendix F for a complete list). The investment policies are generous, and

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[7] This is an updated baseline case from our first round of work, which was developed prior to the passage of the IRA. The BAU in the first round of work excluded all CLCPA policies and the IRA.

[8] We used New York–specific assumptions about transportation vehicle miles traveled and made some adjustments to our assumptions about gas supply to avoid potentially biased results.

the source funding is not limited to the revenue generated by the program. An emissions budget was set for the sectors we model based on the state's emissions inventory and emissions reduction pathways analysis (see Appendix E for details).

Obligated entities in our sectors have full access to bid on allowances in an auction and trade among themselves until the allowances are held by entities with the highest willingness to pay. This policy case has no facility-specific or sector-specific limits on emissions. The emissions cap in the FTC for our sectors is 82.4 MMT CO_2e, which reflects a 40 percent reduction from 1990 levels on an economy-wide basis (see Appendix E for full methodology), and a 22 percent reduction from the 2030 BAU (no cap-trade-and-invest policy).

The final policy case we model is the **restricted trading case (RTC)**, where specific guardrails are implemented to prevent disproportionate pollution burdens and prioritize emissions reductions in DACs:

1. facility-specific caps on power generators that force each facility to reduce emissions at the economy-wide rate (40 percent) between 1990 and 2030[9];
2. sector-specific caps that force each modeled sector to reduce emissions by a minimum amount from 1990; and
3. a prohibition on trading between sectors.

The RTC includes the same investment policies as the FTC (see Appendix F for a complete list). The total emissions budget is the same as the FTC, but the sector-specific caps lead to unique allowance prices in each sector, based on the underlying cost of mitigating CO_2. Table 1 shows the required emissions reductions in each sector, and the reasoning for those caps developed in consultation with EJ stakeholders.

Table 1. Required Emissions Reductions, by Sector

	Residential	Transportation	Power sector
Percentage reduction	65%	21%	88%
Reasoning	Reduction is higher than 40% because residential decarbonization is important for improving air quality in high-density areas.	Reduction is lower than 40% to minimize increases in gasoline prices and because transportation sector, with zero-emissions vehicle mandates in place, is less responsive to a carbon price. We explored pushing transportation sector to economy-wide target of 40% and found gasoline prices to be extremely high.	Reduction is much higher than 40% because of electricity-specific goals established in CLCPA. The selected cap was set to keep electricity prices low and encourage electrification and reduce energy burdens.

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[9] Our electricity model does not have data for 1990 and uses base-year data for 2016 instead. We therefore estimate the percentage reduction required from 2016 levels to achieve a 40 percent reduction from 1990, using the statewide emissions as a benchmark for comparison of 1990 and 2016.

Several policy design elements are included in both policy cases: compliance entities cannot fulfill their obligations by purchasing offsets, and upstream methane is included in the emissions accounting for each entity. Because of modeling limitations, we could not represent carbon allowance banking, borrowing, or free allocations.[10] We also do not model linkage with other state cap-and-trade programs, such as those in California and Washington State, but we do include the Regional Greenhouse Gas Initiative (RGGI).[11] We estimate demand for allowances in other sectors to establish the emissions budget for our modeled sectors. See appendices for additional detail on our methods.

Environmental justice stakeholders consulted in this research process[12] also stated a preference for prohibiting trading in a secondary allowance market and establishing a price floor to ensure that the revenue from the program is collected by the state, rather than by private entities trading allowances. Our modeling is consistent with a price floor that is at or below our model prices, and when we discuss revenue, we refer to the total amount spent on allowances. We were unable to model a framework with a market price set by auction and no allowance trading in a secondary market.

5. Results

We find that the implementation of either cap-trade-and-invest scenario in New York would significantly decrease emissions, encourage clean technology adoption, and have meaningful effects on different cost indicators, relative to the BAU case.

For the full trading case (FTC) relative to the BAU and for the restricted trading case (RTC) relative to the BAU and the FTC, we estimated changes in energy demand and technology adoption, energy prices, emissions changes in modeled sectors, and the location of emissions changes in the power sector, with a particular focus on direct $PM_{2.5}$ and NO_X. In an upcoming report we will discuss air quality changes associated with these results.

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[10] Our representation in all cases implies no banking, no borrowing, and no free-allocation in our sectors.

[11] We assume New York State continues to participate in the RGGI, with entities receiving credit in the NYCI program for the amount spent on RGGI allowances.

[12] Guidance was provided by our partners at the New York City Environmental Justice Alliance and by the NYRenews Cap and Invest Working Group.

The RTC prioritizes reducing costs in the transportation sector while also ensuring minimum emissions reductions are achieved in each sector through sector-specific caps. As a result, the sectors we model face different prices for emissions. All sectors face a price of $26.50[13] in the FTC with full trading across sectors; Table 2 shows the prices needed to meet the sector-specific caps in the RTC in 2030. The price differences are relatively small, particularly in the residential and electricity sectors, indicating that the FTC is close to the minimum performance standards in each sector, but falls short in the residential sector specifically.

Regulations and generous subsidies (detailed in Appendix F) contribute to low prices, particularly in the residential sector.

Table 2. Allowance Prices to Meet Sector-Specific Caps (2018$/MT CO_2e)

	Transportation	Residential	Electricity
2030	$18.40	$28.18	$24.25

Facility-specific caps may also impact allowance prices. Because the RTC includes both sector-specific caps and facility-specific caps, adding the facility-specific caps would only impact prices in the electricity sector. Our modeling indicates these effects would be very small. Adding facility-specific caps does not significantly alter overall demand for allowances from the power sector, and in an exploratory analysis we estimated that facility-specific caps would decrease allowance prices by less than 15 cents in the electricity sector. Without sector-specific caps, facility-specific caps in the power sector could impact economy-wide allowance prices and emissions in other sectors. Our modeling tools are limited in their ability to estimate this effect, but we discuss the information we do have on this topic in Appendix D.

We find that adding sector-specific caps (included in the RTC) changes the distribution of emissions across sectors, relative to the FTC, affecting costs and technology adoption. We find that adding facility-specific caps in the power sector (included in the RTC) changes the distribution of emissions across generators and therefore the location of pollutant emissions in the state. We discuss these findings in detail below. The state-wide emissions differences may seem modest, but the distribution of emissions is the focus of these policy guardrails and this analysis.

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[13] As previously mentioned, this price is an estimate using data from our selected models. A general equilibrium model with all covered sectors included would provide a more accurate projection of the price in the carbon market. Our goal in this analysis is to test how different policy designs affect prices and emissions, not to estimate the allowance price in the NYCI program.

5.1. Behavior and Technology Change

Both implementations of cap-trade-and-invest (FTC and RTC) prompt an increase in clean electricity generation relative to the BAU, which includes IRA and IIJA incentives, the clean energy standard, and the CLCPA clean generation mandates (see above for more detail about the scenarios). Relative to the BAU, both cases deliver more solar generation (a 26 percent increase in the RTC and a 29 percent increase the FTC), 10 percent more wind generation, 1 percent less hydro, and significantly more storage used to serve electricity demand (a 53 percent increase in the RTC and a 59 percent increase in the FTC).[14]

In residential buildings, both implementations of cap-trade-and-invest (FTC and RTC) make oil and natural gas more expensive, which encourages the transition to heat pumps. Relative to the building codes and IRA subsidies included in the BAU, the FTC and RTC both increase heat pump adoption by more than 10 percentage points. This increase in adoption is the combined effect of the carbon price and the investments included in both policy cases (see Appendix F). The subsidies included in the residential sector, which are not limited by program revenue, play a significant role in increasing heat pump adoption.

In the transportation sector, the mandate for zero-emissions vehicles (ZEVs) included in the BAU is a primary driver of the shift to cleaner vehicles and lower emissions. Both cap-trade-and-invest designs (FTC and RTC) drive some additional changes by increasing the price of fuel and the point-of-sale rebate for consumers buying new ZEVs (one of our assumed investments of cap-trade-and-invest revenue).[15] Both the rebate and the increased fuel price encourage greater adoption of ZEVs. The increased fuel price also depresses auto use in favor of less costly modes of transport like transit. The slight changes in EV adoption relative to BAU (illustrated in Figure 2) demonstrate how far the ZEV mandates are pushing the transportation sector and the relatively inelastic demand for gasoline and internal combustion engine vehicles when the mandates are fulfilled.

The sector-specific caps in the RTC slightly affect the rate at which clean technologies are adopted relative to the FTC (see Figure 2). Figure 2 shows a summary of the major technologies and how their adoption rates are affected by each policy case. The RTC yields slightly greater clean technology adoption in the residential sector, specifically a 0.01 percentage point increase in heat pump penetration. The lower price in the electricity sector yields slightly lower (about 0.3 percentage points) renewable energy generation while the lower prices in the transportation sector also have a small effect (about 0.5 percentage points) on EV stock. These differences are small because the carbon prices needed to achieve the sector specific caps (RTC) do not vary widely from the price in the economy-wide cap case (FTC).

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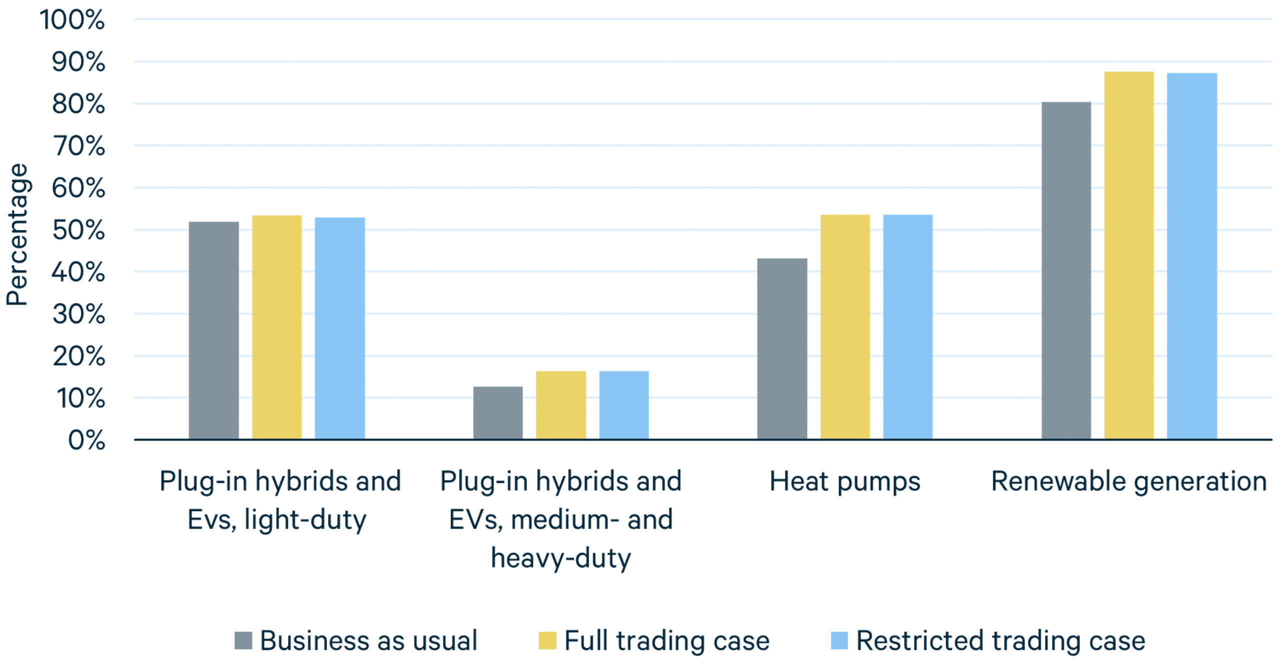
[14] Our model does not hinder renewable buildout in 2030 based on regulatory obstacles such as siting, permitting, and interconnection.

[15] See Appendix F for more detail on complementary policies included in our modeling, as reflections of the "invest" side of cap-trade-and-invest. Congestion pricing is not included in this modeling.

Figure 2. Technology Changes Driven by Cap-Trade-and-Invest (All Policy Cases)



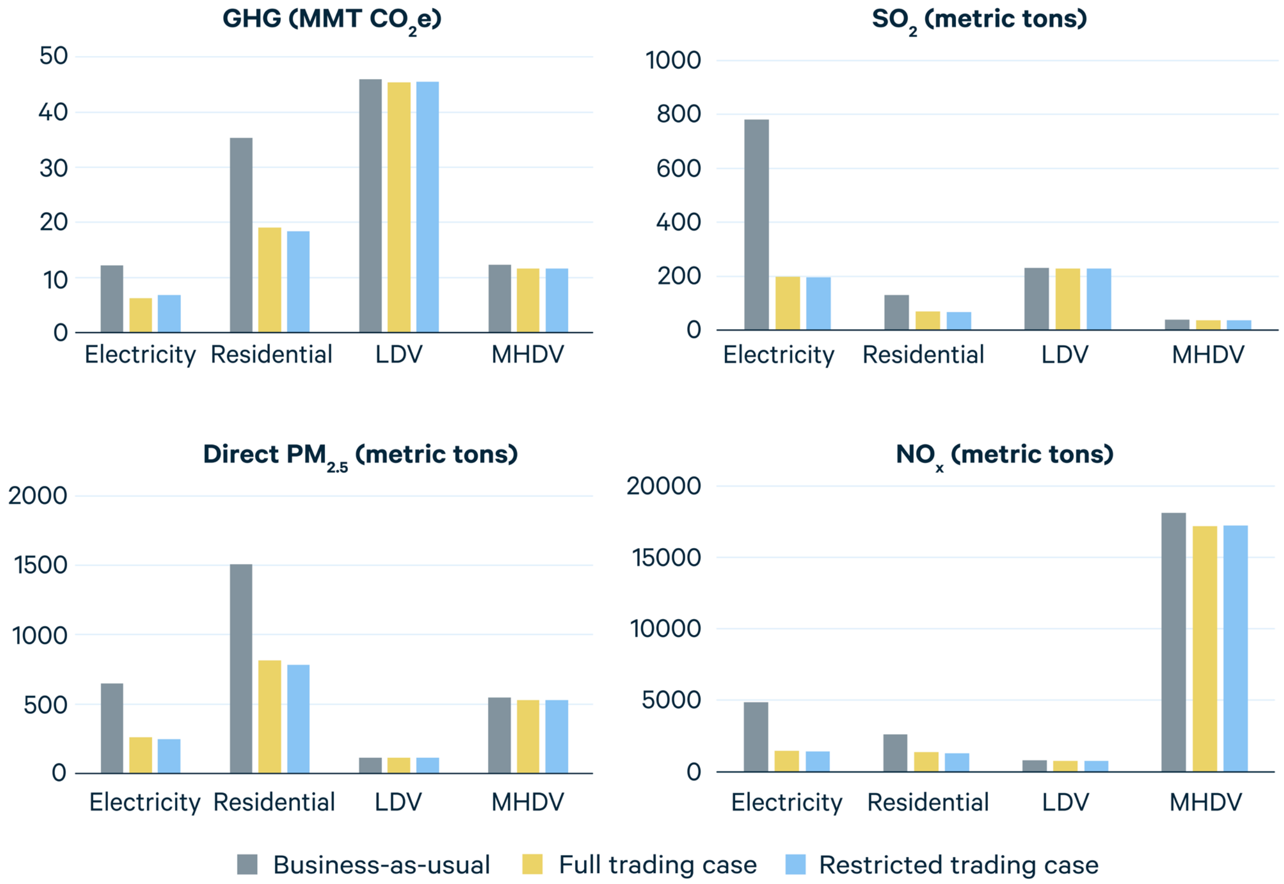
5.2. Emissions

The technology adoption changes described above yield GHG emissions reductions. Both cap-trade-and-invest designs set an emissions budget according to CLCPA mandates. In both policy cases the cap is the same—40 percent below 1990 levels, which is a 22 percent reduction relative to the BAU. When allowing sectors to trade and find the least-cost reductions, as in the FTC, we see a 2 percent decrease in GHG emissions in the transportation sector, a 46 percent decrease in the residential sector, and a 48 percent decrease in the power sector, relative to the BAU. The variability in those emissions reductions reflects the sectors' relative sensitivity to carbon pricing and the ambition of decarbonization policies included in the BAU, like the ZEV mandate, which drives transportation electrification without a carbon cap. Figure 3 summarizes the emissions reductions for all policy cases.

While the economy wide emissions reductions are fixed to meet the CLCPA mandate, the sector specific caps shift emissions reductions across sectors. The sector-specific caps in the RTC lead to 0.2 percent higher GHG emissions in the transportation sector (relative to the FTC) and about 8 percent higher CO_2e emissions in the power sector to save on costs due to the lower CO_2e permit price required to meet the sector specific cap. These emissions differences reflect the relative ambition of the caps in each sector, which were identified by stakeholders consulted in this process as part of a research exercise based on the estimated impact on household costs and emissions (see Table 1 for full reasoning). Sector-specific caps could be set more restrictively in any sector, but it would increase the price of allowances in that sector.

Not only do the modeled cap-trade-and-invest policy cases reduce GHG emissions, the FTC and RTC also lead to copollutant reductions. The FTC causes estimated statewide reductions below the BAU of 55, 21, and 39 percent for SO_2, NO_x, and direct $PM_{2.5}$, respectively. The facility-specific and sectoral caps in the RTC have a greater effect on some copollutants, even though the GHG reduction targets are the same. Compared with the FTC, the RTC SO_2 reductions are roughly half a percentage point greater and direct $PM_{2.5}$ reductions are 2 percentage points greater. These are relatively small differences, but they highlight that copollutants reductions are not perfectly correlated with GHG reductions across all sectors, and emissions reductions in some sectors yield greater copollutant emission reductions. We will explore how this impacts air quality more in the upcoming report analyzing air quality results.

Figure 3. Emissions by Policy Case, by Sector, 2030



5.3. Prices and Revenue

Besides encouraging carbon emissions reductions and the subsidization and adoption of low-carbon technologies, cap-trade-and-invest also impacts energy and fuel prices. Table 3 shows a summary of three major household energy costs—electricity[16], gasoline for vehicles, and natural gas for home heating—under the policy scenarios compared with the BAU. We find that, relative to the FTC, the RTC delivers lower gasoline prices and slightly lower electricity prices while it pushes natural gas prices higher. This reflects the relative ambition of the sector-specific caps (see Tables 1 and 2). Our modeling shows adding electricity sector facility-specific caps to either cap-trade-and-invest policy has virtually no impact on residential electricity prices in the RTC.

Table 3. Household Energy Prices, by Policy Case

Price	BAU	FTC	RTC
Gasoline	$3.17/gallon	$3.50/gallon	$3.40/gallon
Residential electricity	$0.1912/kWh	$0.1929/kWh	$0.1926/kWh
Residential natural gas	$3.20/MMBtu	$3.95/ MMBtu	$4.00/MMBtu

These prices, which drive household transportation and home energy costs, may have varying effects on different income groups. For the 10 regions (the residential model divides New York State into geographic groupings from the US Census called Public Use Microdata Areas, or PUMAs) with the lowest income, the combination of heat pump subsidies and increased efficiency leads to slightly lower home heating costs (less than 1 percent) for the FTC and RTC relative to BAU. For the 10 highest-income PUMAs in the state, home heating costs increase (by about 15 percent) in both the FTC and RTC because access to electrification incentives is lower for higher-income groups, leaving them more exposed to increased natural gas prices. For both income groups, the FTC presents slightly lower costs than the RTC because the sector-specific cap in the RTC drives natural gas prices higher to achieve greater emissions reductions in the sector. Exposure to the higher natural gas price is relatively low due to large investments in residential electrification.

Low-income PUMAs see a small increase in home heating costs, averaging $1.77 per household per year in the RTC compared to the FTC. For the highest-income PUMAs, home heating costs rise $3.62 per year. At the same time, the lower gas prices in the RTC would mean that the average low-income drivers would save approximately $18

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[16] The electricity prices in the RTC reflect the combined impacts of the lower carbon price in the sector and the facility-specific caps.

dollars per year in vehicle operating costs based on average consumption.[17] These findings indicate that adjusting sectoral ambition can yield the same overall emissions reductions while mitigating some household costs.[18] The New York State Climate Affordability Study goes into detail about how the Consumer Climate Action Account, funded by program revenue, may be used to further ameliorate consumer costs (NYSERDA and DEC 2023).

We find that both the FTC and the RTC can raise significant revenue, but neither raises sufficient revenue to cover the cost of the complementary policies modeled under the cap-trade-and-invest designs (see Appendix F). In the sectors we model, the FTC could generate approximately $2.2 billion in revenue in the year 2030 whereas the RTC could raise approximately $1.7 billion in revenue. For comparison, between 2025 and 2030 average state spending on subsidies and rebates in the residential and light-duty transportation sectors is about $2.7 billion per year for both policy cases.[19] Unmodeled sectors that are anticipated to be covered under the program, like commercial buildings, would provide additional revenue, but free allocation of allowances in other sectors, like energy-intensive trade-exposed (EITE) industries, would limit opportunities to add to program revenue. These findings indicate that additional funds, beyond the cap-trade-and-invest revenue, would be needed to cover the modeled subsidies, provide consumer rebates, and keep allowance prices low. Additional analysis quantifying revenue and spending across all covered sectors in the program and details about the planned subsidies by the state will be valuable in assessing allowance prices and household costs.

5.4. Location of Emissions Changes

Relative to the BAU, we find that a cap-trade-and-invest program drives emissions changes across the state, but in some cases, reductions are concentrated regionally. For example, transportation and residential emissions reductions are concentrated in areas with more dense populations. The upcoming air quality report will investigate the net effect of emissions changes resulting from the sector-specific caps, which push for greater reductions in the residential sector while relaxing the pressure on the transportation sector.

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[17] This estimate is based on the average gasoline consumption across the policy cases for the bottom 25 percent of NY households by income. The savings on transportation for households that do not own a vehicle would be less than $18 annually, though lower gas prices may affect other costs they face. Households that live in smaller homes and spend less on home heating would also be less sensitive to higher natural gas prices in the RTC.

[18] These findings are sensitive to the level of subsidization in the sector, which affects household costs.

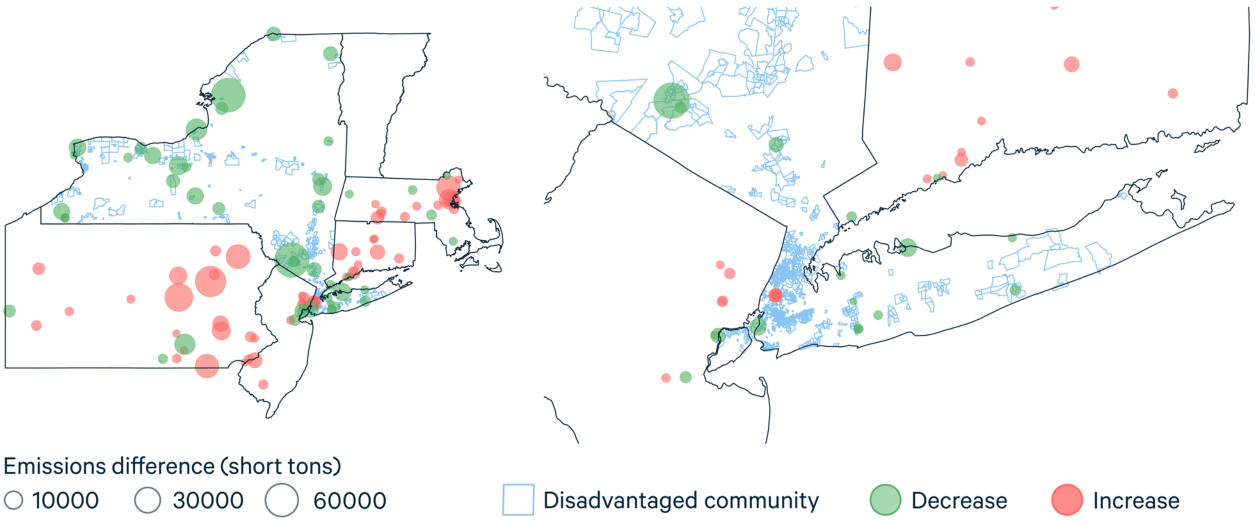
[19] We do not have total revenue numbers between 2025 and 2030 because only some of our models run interim years.

Environmental justice advocates are particularly interested in the location of emissions changes for stationary emissions sources in the industrial and power sectors, and their proximity to DACs. Over two-thirds of emitting New York power plants in our data are within one mile of a DAC. Figures 4A and 4B show the location of the power sector's direct $PM_{2.5}$ emissions and NO_x emissions, respectively. Red dots indicate power plants where emissions have increased as a result of the FTC, and green dots show locations where emissions have decreased (relative to the BAU).[20] The size of the dot reflects the magnitude of the change.

Relative to BAU, most power plants in New York State decrease $PM_{2.5}$ emissions under the FTC, but 11 plants increase their emissions. Only six plants increase their emissions by more than one short ton of $PM_{2.5}$, which is why they are hard to see on these maps relative to the large emissions decreases in green. In Figure 4B, a similar pattern is observed. Most plants in NY decrease NOX emissions in the FTC relative to the BAU, except for 16 plants.

Emissions increases can be seen in adjacent states, close enough to potentially impact New York's air quality. Although a carbon border adjustment is included for imported electricity, these red dots indicate that emissions leakage is present.[21] The pollution impact of these out-of-state increases on New York communities will be covered in the upcoming air quality report.

Figure 4A. Changes in Direct $PM_{2.5}$ Emissions, by Electric Power Generator, BAU to FTC, 2030



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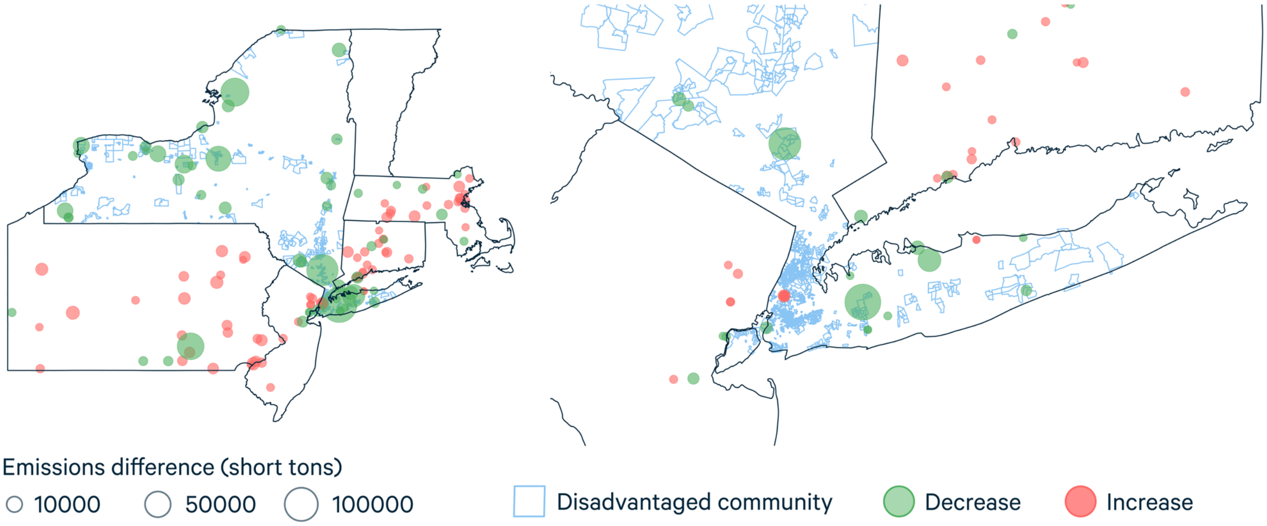
[20] Changes less than 10 short tons over the course of 2030 are excluded so that more substantive changes are visible.

[21] Our model estimates power sector leakage rates over 100 percent across all cap-trade-and-invest policy cases (106 percent for FTC and 108 percent for RTC). Community impacts in New York is the focus of this analysis, but emissions leakage is an important consideration for climate policy.

Figure 4B. Change in Direct NOx Emissions, by Electric Power Generator, BAU to FTC, 2030



Relative to the historical baseline, we find that under BAU (without the FTC or RTC), seven generating units increase their emissions between 2016 and 2030, and 43 fall short of the economy-wide emissions reduction trajectory forced by the carbon cap. Under the FTC, three generating units increase their emissions from 2016, and 10 fall short of the economy-wide emissions reduction trajectory (6 of which are within a mile of a DAC).

A key goal of the mandatory emission reductions at power-generating facilities included in the RTC is to more evenly distribute emissions reductions across facilities, to avoid contributing to or creating pollution “hot spots,” or concentrated pollution increases in a small area, particularly in or near DACs. The mandatory emissions reductions in the RTC force all power plants to decrease their emissions relative to 2016 levels in line with the economy-wide trajectory (which the CLCPA mandates to be a 40 percent reduction from 1990 levels by 2030).

Table 4 shows the average percentage reductions in emissions from 2016 to 2030 at DAC-adjacent and non-DAC facilities under each policy case. In the BAU, which includes the clean energy standard and new clean generation mandates in the CLCPA, the average emissions reductions from the historical baseline are lower for DAC-adjacent facilities (which we define as any facility within one mile of a DAC) compared with all other facilities. This pattern persists under the FTC as well as the RTC with no facility-specific caps, though the disparity between DAC-adjacent facilities and all other facilities decreases. The table shows that once facility-specific caps are added (RTC, facility-specific caps) the disparity is slightly reversed.

Increases in the average percent reduction with facility-specific caps are driven largely by the restrictions on the facilities that do not meet the 40 percent reduction standard without the caps in place (those at the “tail end” of the distribution), indicating that facility-specific caps do serve to control pollution outliers. These percentage reductions are nearly identical for SO_2 and NO_x emissions.

As mentioned above, adding facility-specific caps to the RTC has almost no impact on residential electricity prices. Furthermore, even though the electricity price is higher under the FTC, average percentage reductions by facility are still slightly lower than in the RTC.

Table 4. Average Percentage Reductions in Direct $PM_{2.5}$ Emissions, by Facility, from 2016 Levels

Location of facility	BAU	FTC	RTC, no facility-specific caps	RTC, facility-specific caps
Within 1 mile of DAC	49.1%	78.1%	80.0%	88.8%
All other facilities	62.2%	87.0%	85.6%	87.1%

Note: This table excludes one existing facility that had less than 1 MWh of generation in 2016. That facility is still required to reduce emissions relative to BAU with facility-specific caps and are included in the rest of the analysis, but their results would skew this table on a percentage basis. That facility does not produce more than 30 MWh per year in any policy case.

Although the average percentage emissions reductions across facilities are important, absolute emissions changes can be lost in those statistics. For example, a 40 percent reduction at a small facility is a minor change in absolute emissions relative to a 40 percent reduction at a large facility. Furthermore, a cluster of emissions reductions or increases concentrated in an area could be consequential for surrounding communities. To determine these granular details, we need to look at emissions changes by facility and location.

Figures 5A and 5B show the location of direct PM2.5 emissions and NOx emissions changes, respectively, when facility-specific caps are added (compared with sector-specific caps alone). Red dots indicate power plants where emissions increase (28 units in the region, 14 in New York) and green dots show locations where emissions decrease because of the caps (38 in the region, 17 in New York).[22] Emission increases may happen when the reduced supply from generators that hit their caps is substituted by supply from other emitting facilities that were below their caps. Out-of-state facilities are not subject to any mandatory emissions reductions, but they are subject to a carbon border adjustment for imports.

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[22] Changes less than 10 short tons over the course of 2030 are excluded so that more substantive changes are visible.

Figure 5A. Change in Direct $PM_{2.5}$ Emissions When Facility Caps are Added, 2030

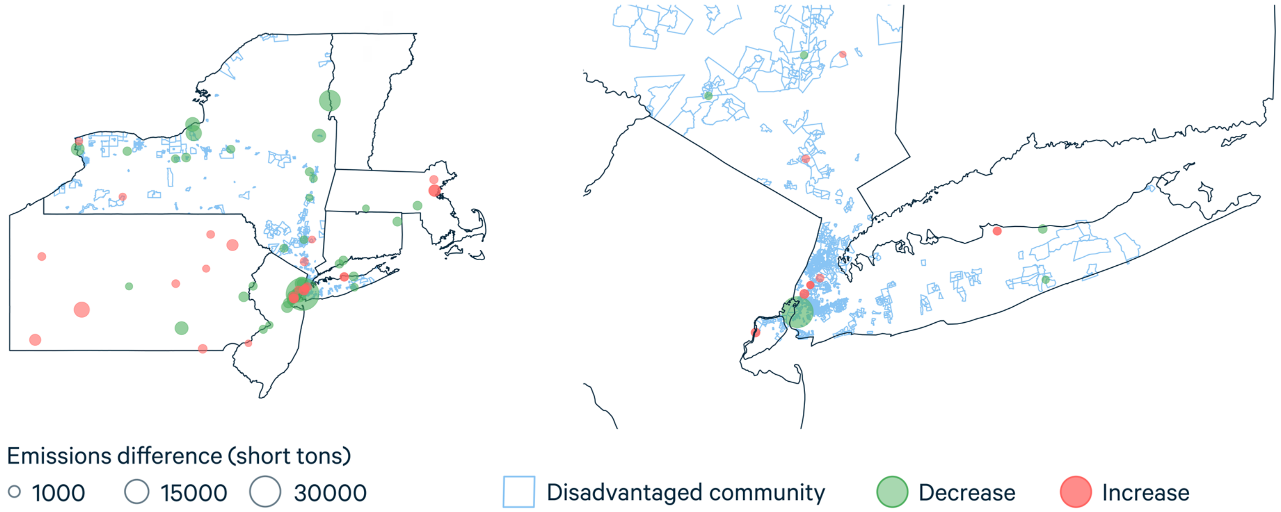

Figure 5B. Change in Direct NO_x Emissions When Facility Caps are Added, 2030

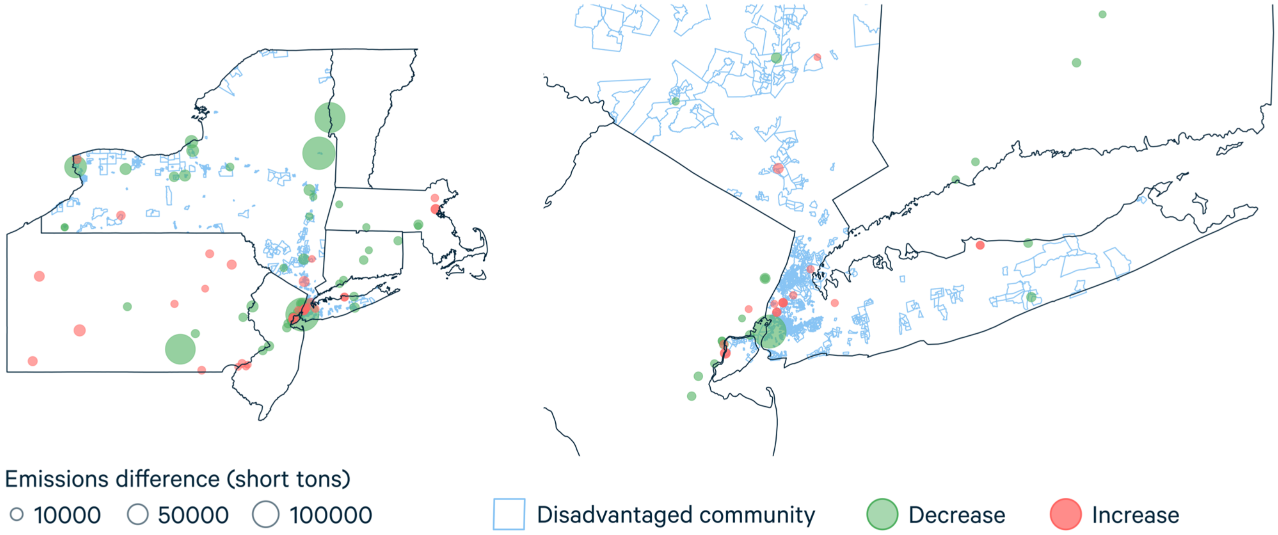

Figure 5 shows that the facility-specific caps result in significant annual emissions reductions at some facilities and small, distributed emissions increases to compensate for the reduced supply. For reference, for the New York State facilities that increase emissions, the average annual increase is 22 short tons of $PM_{2.5}$ (1,480 tons in all). Among facilities that reduce emissions, the average annual reduction is 581 short tons of $PM_{2.5}$ (60,429 tons in all). For DAC-adjacent facilities that increase emissions, the average increase is 25 short tons of $PM_{2.5}$ (1,246 tons in all). For DAC-adjacent facilities that reduce emissions, the average reduction is 707 short tons of $PM_{2.5}$ (45,972 tons in all). Consequently, adding facility-specific caps to the RTC reduces direct $PM_{2.5}$ emissions near DACs on net by over 44,000 tons. As shown in Figure 5, emissions also increase at some facilities outside the state when facility-specific caps are introduced, particularly in Pennsylvania, as New York electricity suppliers face higher restrictions on emissions. Direct $PM_{2.5}$ emissions within one mile of a DAC are still lower on net (by over 51,000 tons) when emissions in neighboring states are considered. About 76 percent of the $PM_{2.5}$ emissions reductions associated with adding facility-specific caps occur within a mile of a DAC (at DAC-adjacent facilities). This is in part because most power sector facilities (69 percent) are located within a mile of a DAC.

Our analysis indicates that the facilities in DACs and non-DACs experience similar total percentage reductions in direct $PM_{2.5}$ emissions. As shown in Table 5, when we sum emissions by (a) DAC-adjacent facilities and (b) all other facilities and calculate the percent reduction from 2016 emissions levels, the addition of facility-specific caps increases percent reductions for both groups of facilities. However, the change in emissions reductions on a percentage basis is virtually the same for DAC adjacent facilities and all other facilities. This means the difference in percent emissions reduced from 2016 between DAC adjacent facilities and all other facilities (around 3.5 percentage points in the FTC) remains even with the facility-specific caps in place. The difference in emissions reductions between the two regions is greatest in the BAU, without any carbon pricing or facility-specific caps.

Table 5. Total Percentage Reductions in Direct $PM_{2.5}$ Emissions, from 2016 Levels

Location of facility	**BAU**	**FTC**	**RTC, no facility-specific caps**	**RTC, facility-specific caps**
Within 1 mile of DAC	75.6%	90.4%	89.5%	90.9%
All other facilities	80.3%	93.9%	93.3%	94.5%
Difference	4.7pp	3.5pp	3.8pp	3.6pp

The importance of these emissions changes for air quality in DACs will be quantified more directly in the upcoming air quality modeling report, which analyzes how precursor emissions combine and migrate to affect local air quality in New York. In the meantime, our emissions work provides insights on direct pollutants and their proximity to disadvantaged communities, particularly in the power sector.

6. Conclusion

Any cap-trade-and-invest policy in New York State must meet Section 7(3) requirements of the CLCPA by preventing disproportionate burdens and prioritizing copollutant emissions reductions (direct $PM_{2.5}$, SO_2, and NO_X) in disadvantaged communities. Without considerations for low-income communities and communities of color, the path to meeting the CLCPA mandates in New York State may leave disadvantaged communities to continue suffering from health-harming air pollution for longer than their privileged neighbors. For the climate and environmental stakeholders we partnered with and consulted, a cap-trade-and-invest program that prioritizes communities of color and low-income communities would ban, or severely restrict, GHG allowance trading and ensure that copollutant emissions reductions and the related air quality benefits are distributed equitably across the state, with greater improvements realized in historically overburdened communities.

This research quantifies the cost and emissions (GHG and copollutants) effects of different cap-trade-and-invest policy designs in New York State, including various environmental justice (EJ) guardrails, as well as a business as usual (BAU) case without a cap-trade-and-invest policy.

Our work in this phase looks specifically at how restricted trading through facility-specific caps and sector-specific caps on GHG emissions affect copollutant emissions levels and costs. A follow-up report will focus on ambient concentrations of $PM_{2.5}$ throughout the state. The guardrails we test act as “backstops” or minimum performance standards for each sector and each power sector facility, while still achieving the same overall state GHG reductions. Overall, we find that if the state provides significant funds for electrification investments (such as heat pumps), the modeled guardrails (facility- and sector-specific caps) could secure additional $PM_{2.5}$, SO_2 and NO_x emissions reductions near DACs and modest fuel savings for households.

We estimate that adding facility-specific GHG caps at each power plant increases the average direct $PM_{2.5}$ emissions reduction from 80 to 89 percent for DAC-adjacent facilities, compared to a cap-trade-and-invest system with no facility-specific caps. SO_2 and NO_x emission percentage reductions are nearly identical to $PM_{2.5}$ reductions. These caps lead to a total net reduction in $PM_{2.5}$ emissions of over 44,000 tons in the areas surrounding DACs, with large emissions decreases at a few facilities, and relatively smaller increases in emissions at other facilities to compensate for the reduced supply. The benefits of facility-specific caps accrue mostly to disadvantaged communities because they are the most exposed to power sector emissions, since over two thirds of facilities are within a mile of a DAC.

Furthermore, we find that when the power sector faces no price in the BAU, average emissions reduction rates at DAC-adjacent facilities fall far behind facilities outside 1 mile of a DAC. In a cap-trade-and-invest program where the power sector is exempted from the requirement to purchase allowances (a scenario New York State is considering), high electrification could exacerbate this divide even as it drives emissions reductions in other sectors. In a cap-trade-and-invest program, where prices are uncertain, facility-specific caps could ensure a minimum standard for improvement at each facility.

We find that mandatory GHG emissions reductions for specific sectors rather than economy-wide trading can influence some household costs without affecting overall GHG emissions outcomes. Setting lower ambition in the power and transportation sectors reduces gasoline prices and electricity prices; setting higher ambition in the residential sector has a small upward effect on natural gas prices. For the same economy-wide emissions reductions, pushing for more ambition in the residential sector could mean more pollution reductions in populous areas (see forthcoming air quality report) while allowing lower gasoline prices in the transportation sector. When generous subsidies for electrification are included, sector specific caps could reduce salient energy costs (including gasoline and electricity) for the average low-income household.

The inclusion of sector-specific and facility-specific caps in the cap-trade-and-invest program could help the state meet CLCPA requirements to not disproportionately burden DACs, but complementary policies and additional funding could also play a key role in meeting the CLCPA mandates. Subsidies to support electrification and investments in infrastructure in DACs can provide direct benefits to New Yorkers. The complementary policies we model in the light duty vehicle and residential buildings sectors would require $2.7 billion in average annual investment in subsidies and rebates. This exceeds the revenue raised by cap-trade-and-invest in each of the policy cases. Significant funds would also be needed to cover the subsidies in the medium- and heavy-duty vehicle sectors. If investments are limited to revenue from the cap-trade-and-invest program, we would expect higher prices in the program and higher fuel costs for households. Other policies that specifically support equity goals of the CLCPA include capping harmful copollutants in addition to carbon emissions, enforcing mandatory GHG or copollutant emissions reductions in the industrial sector, and targeting investments to improve local air quality to those communities that need it most.

In short, this part of our research finds that including facility-specific caps in the power sector can ensure a minimum level of reductions for each facility with no increase in electricity prices compared with not having facility-specific caps. Additionally, sector-specific GHG caps with no trading between sectors can help ensure a minimum level of GHG and copollutant emissions reductions in each sector while mitigating key household costs. Based on the results of this analysis and other research , NYC-EJA believes that setting a minimum GHG emissions reduction standard for all facilities is one critical protection for DACs and an essential component of any cap-trade-and-invest system.

However, this report still does not give us a complete picture of the various effects of a cap-trade-and-invest program. In our next report, we will analyze the air quality implications of these policy scenarios and resulting emissions changes. We will specifically quantify the secondary $PM_{2.5}$ concentrations in communities and report which communities, including DACs, benefit, and to what extent.

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Appendix A. Background on Economic Models

Appendix adapted from Krupnick et al. (2023)

A.1. Power Sector

The Engineering, Economic, and Environmental Electricity Simulation Tool (E4ST) is power sector modeling software built to project the effects of policies, regulations, power infrastructure additions, demand changes, and more (E4ST 2022). E4ST simulates in detail how the power sector will respond to such changes. It models successive multiyear periods, predicting hourly generator and system operation, generator construction, generator retirement, and various other outcomes in each period. The E4ST model of the United States and Canada contains the 19,000 existing generators with their detailed individual characteristics, tens of thousands of buildable generators, including location- and hour-specific wind and solar data, and all of the high-voltage (>200 kV) transmission lines as well as chronically congested lower-voltage transmission lines. E4ST's advantages over other models include its high spatial detail, its realistic representation of power flows and system operation, its comprehensive benefit-cost analysis capabilities, its high-quality generator data, its inclusion of Canada, and its adaptability, transparency, and shareable nature. E4ST has been used to analyze various policies and investments. It has also been used for multiple peer-reviewed papers in leading journals. E4ST was developed by researchers at Resources for the Future, Cornell University, and Arizona State University, with funding, input, and review by the US Department of Energy, the National Science Foundation, the New York Independent System Operator, the Power Systems Engineering Research Center, the Sloan Foundation, Breakthrough Energy, and others.

A.2. Light-Duty Vehicles

This description of the light-duty model is adapted from Funke et al. (2023). The model for light-duty vehicles contains two components: new-vehicle sales and on-road fuel consumption. The first component characterizes vehicle sales by year (2018 through 2030) and region (California, other ZEV states, and all other states, to enable an explicit representation of the ZEV program). On the demand side of the market, consumers choose vehicles that maximize their subjective well-being, which depends on the vehicle's price, fuel costs, horsepower, size, and other features, such as all-wheel drive. Preferences for those vehicle attributes vary across 60 demographic groups, defined by income, age, urbanization, and geographic region.

Consumer preferences are estimated based on survey responses from 1.5 million new-car buyers between 2010 and 2018. The survey data include information about household demographics, such as income, as well as detailed information about the vehicle purchased. Vehicles are defined at a highly disaggregated level, with about 1,200 unique vehicle models offered each year. Consumer preferences for fuel costs, fuel type, and other vehicle attributes are estimated from their vehicle choices.

Each manufacturer chooses vehicle prices and fuel economy (and decides whether to introduce electric vehicles) to maximize profits while meeting regional ZEV standards and federal fuel economy and GHG standards. Vehicle prices depend on marginal costs, consumer demand, ZEV standards, and federal fuel economy and GHG standards. Manufacturers select a larger markup of prices over marginal costs when consumer demand is less sensitive to price. Because high-income consumers are typically less price responsive than low-income consumers, markups tend to be higher for vehicles purchased by high-income buyers than for vehicles purchased by low-income consumers. The ZEV, fuel economy, and GHG standards cause manufacturers to reduce prices of electric vehicles and increase prices of gasoline vehicles. These price changes help manufacturers achieve the standards.

Each year, manufacturers also decide whether to introduce new electric vehicles to the market. Vehicle production and entry costs, as well as shadow prices of the standards, are estimated from observed choices of vehicle prices, fuel economy, and entry between 2010 and 2018, under the assumption that each manufacturer makes these choices to maximize its own profits.

We simulate the equilibrium in a market (model year and region) given assumptions about the total number of consumers in the market, fuel prices, battery costs, electric vehicle subsidies, and standards. For each simulated market, the output includes entry of new electric vehicles and prices, fuel economy, and sales of each vehicle. The number of consumers in the market and fuel prices are taken from the EIA AEO 2021. Battery costs are from 2021 projections by Bloomberg NEF. Marginal costs of electric vehicles decrease over time in accordance with the vehicle’s battery capacity and the projected battery cost reduction. Declining battery costs cause manufacturers to reduce electric vehicle prices over time, all else equal.

The output of the new-vehicle component feeds into the on-road fuel consumption component of the model. For each county and year, this component of the model characterizes total gasoline and electricity consumption and tailpipe and upstream emissions from vehicles owned by households. Vehicles are defined by fuel type (gasoline, diesel fuel, electric, and plug-in hybrid), class (cars and light trucks), age, and county.

Simulations of the model begin with the stock of on-road vehicles in 2017 that is estimated from the National Household Travel Survey (NHTS). We compute fuel consumption rates for gasoline and plug-in hybrid vehicles by vehicle age, class, and state from the NHTS. The state-level vehicle stocks and fuel consumption rates are disaggregated to the county level using the Bureau of Transportation Statistics LATCH Survey.

At the beginning of the year, a fraction of vehicles are scrapped, where scrappage rates depend on vehicle age, class, and vehicle price and are estimated from historical registrations data from RL Polk. Scrappage rates are adjusted by registration taxes according to estimates from Jacobsen and van Benthem (2015).

The on-road vehicle stock is augmented by the new vehicles sold in the vehicle market component of the model. From that component, we compute new-vehicle sales by fuel type, class, and region. We compute the average fuel consumption rate (gallons per mile traveled) for gasoline and plug-in hybrids by region. The regional estimates are disaggregated to the county level using the LATCH data.

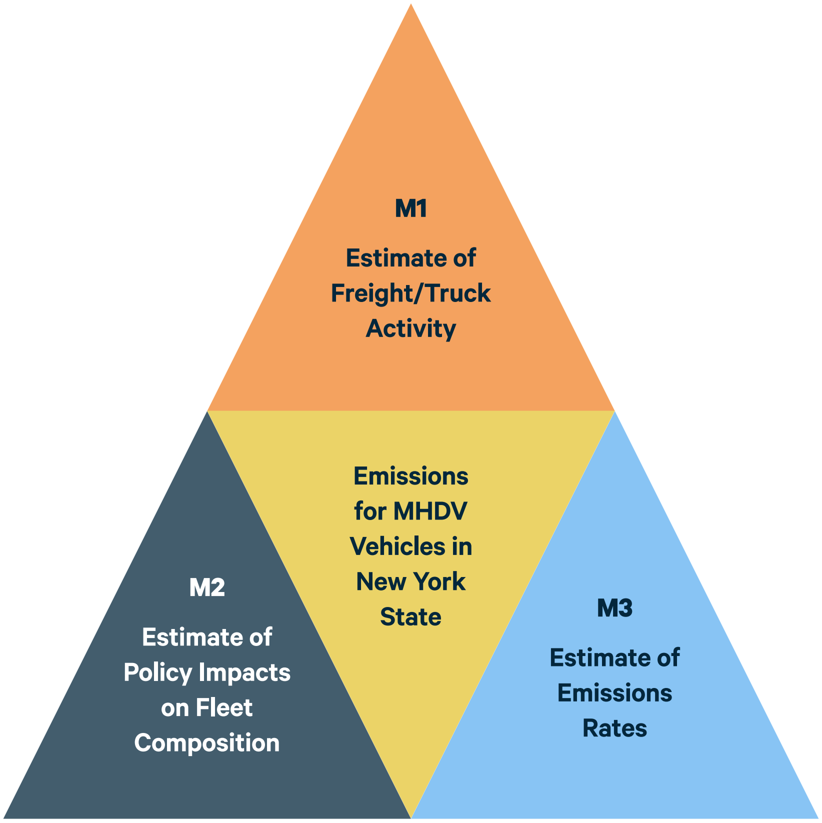
Total national vehicle miles traveled (VMT) data are obtained from the AEO 2021. National VMT is allocated across counties and vehicles according to the per mile fuel costs and consumer driving preferences that are estimated from the 2017 NHTS and vary by vehicle class and age. Compared with the baseline, a scenario with higher fuel costs causes total VMT to decrease according to the assumed elasticity of VMT to fuel costs of –0.1. Fuel costs also affect the distribution of VMT across vehicles.

The model is then iterated forward one year, and the entire process is repeated. The output of the model includes VMT, tailpipe and upstream emissions, gasoline consumption, and electricity consumption by fuel type, county, and year for 2017–2030.

A.3. Medium- and Heavy-Duty Vehicles

Prior to this work, there was no model that could predict MHDV flows for New York at the resolution required to do air pollution modeling, or to estimate the local impacts from the freight flows to local communities. The latter information is critical considering the goal of estimating community impacts, especially to disadvantaged communities. To overcome this limitation, this project developed a new modeling framework that integrates outputs and information from a set of publicly available sources of socioeconomic data (e.g., Census, ZIP code business patterns), and other truck and economic models. The modeling framework has three main modules (Figure A1).

Figure A1. Key Components of MHDV Modeling Framework



The first module (M1) is used to estimate vehicle activity at a network link level. This is a static representation of truck travel along the primary and secondary highways for different vehicle types for the 2012 baseline and 2030 scenarios. To develop M1, the team integrated outputs and data from the following sources:

- Freight Analysis Framework (FAF) version 4. FAF was developed by the Bureau of Transportation Statistics and the Federal Highway Administration to model aggregate freight flows throughout the nation. M1 uses FAF model outputs to gather the aggregated multimodal freight flows in and out of the major regions in the state.
- New York Best Practice Model (NYBPM). NYBPM is a travel demand model for the New York Metropolitan Transportation Council region with high resolution in the following counties: Manhattan, Queens, Bronx, Brooklyn, Staten Island, Nassau, Suffolk, Westchester, Rockland, Putnam, Orange, and Duchess. Additionally, the model estimates some flows in the network corresponding to some other regions.
- Freight and freight trip generation models for New York State.
- Public Commodity Flow Survey microdata. This information provides shipment-level data on commodities, shipment distances, and modes.

Overall, those various data sources allow estimating aggregated truck flows in the New York network. Integrating the data sets involved several subprocesses. For example, FAF and New York Metropolitan Transportation Council had different projection years and vehicle definitions, as well as their geographic resolution. The team used the various data sets to estimate vehicle type ratios to translate freight flows into truck traffic and estimate short- versus long-haul trip demand, and used indicators of industry-generated flows to infer the vehicle type characteristics and behaviors. For the projections, the process uses linear interpolation to estimate freight flows in the FAF and NYBPM model results for 2030 because FAF projections were available for only 2012 and 2045, and for the New York Metropolitan Transportation Council, only 2025 and 2035 data were available. Additionally, leveraging the increased resolution of the NYBPM, the team estimated adjustment factors for the FAF model in urban areas throughout the state. It was also necessary to create a crosswalk between the vehicle definitions in FAF (two types), the NYBPM (four types), and the five truck definitions in MOVES. The resulting five vehicle types include light commercial trucks (primarily nonpersonal use) (32), single-unit short-haul trucks (52), single-unit long-haul trucks (53), combination short-haul trucks (61), and combination long-haul trucks (62). The final outputs of M1 are VMT per day or year on every network link (modeled) for the baseline and future scenarios for the five vehicle types.

Module 2 (M2) integrates a truck vehicle choice model, a transportation transition (truck turnover) model, and the design of policy scenarios. This was necessary to evaluate the impact of policies to foster the introduction of ZEVs following the California Air Resources Board's Advanced Clean Truck (ACT) rule and the (still under development) Advanced Clean Fleet program, among others discussed in the draft scoping plan for New York State. Specifically, M2 uses the Transportation Transitions Model (TTM), developed at the Institute of Transportation Studies Davis (ITS Davis), which estimates fleet turnover based on sales target requirements (e.g., ACT) considering assumptions about vehicle characteristics and travel activity. Due to a lack of New York data, the research team used assumptions drawn from their expertise and the experience in California, extrapolating to assume that New York would follow a similar trajectory as California. The main outputs of the TTM are stock turnover by model year and major vehicle categories (e.g., diesel, ZEV).

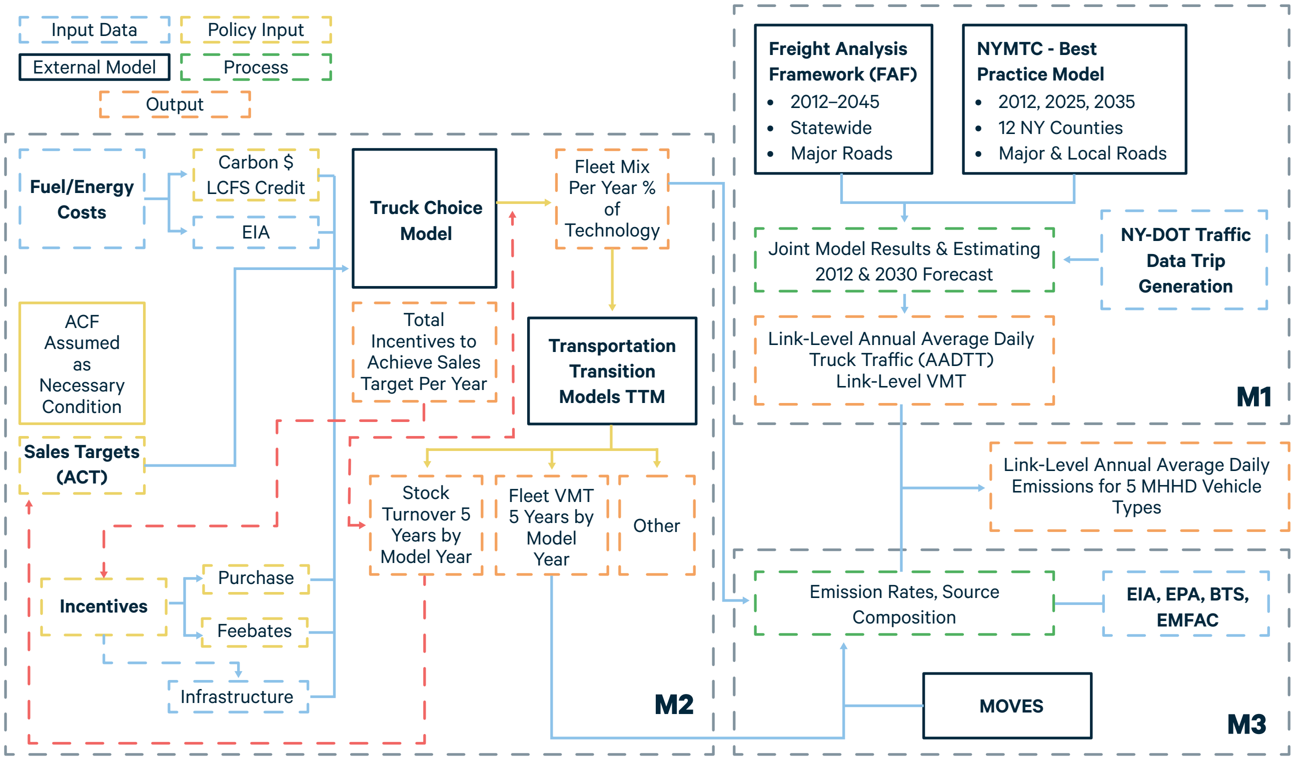
M2 also uses the ITS Davis Truck Choice Model (TCM) to estimate the share of ZEV technologies (e.g., battery electric, hydrogen fuel cell) that satisfy the transition estimates from the TTM, and the level of incentives required to achieve such sales targets. The TCM considers variables and factors such as vehicle specifications, price, fuel or energy efficiency, incentives (e.g., purchase vouchers, infrastructure, feebates, low-carbon fuel standard credits), operational and maintenance costs, and carbon and copollutant costs, among others. The output of the TCM is the fleet mix per year by share of technology.

The team then implemented the FTC and RTC through the TTM and TCM. The final outputs of M2 are then the share of vehicle technologies for various vehicle categories in the policy scenarios. It is important to note that the TTM and TCM estimates are at the state level and are assumed to be uniform statewide. Additionally, the models used in M2 consider the following vehicle categories: heavy-duty long-haul, heavy-duty short-haul, medium-duty delivery, heavy-duty vocational, medium-duty vocational, and heavy-duty pickup trucks. Considering the definitions of the vehicle types from M1 (and MOVES), the team deemed M2 and M1 outputs to be consistent with the five vehicle types from M1.

Finally, module 3 (M3) uses the Environmental Protection Agency's Motor Vehicle Emissions Simulator (MOVES 3) to generate an emissions profile for a vehicle fleet in New York State. As the output of M3, the team estimated an average tailpipe emission rates in grams per mile for various pollutants for the five vehicle types based on MOVES estimates for the 2012 baseline, and a 2030 business-as-usual scenario. Figure B2 shows a schematic of the key inputs, processes, and outputs of the various modeling framework components.

Altogether, the modeling framework then generates a composite emissions rate for the FTC and RTC, modifying the base rates from M3 and the outputs from M2. The scenario-based composite rates are then used to estimate total tailpipe emissions at the link level throughout the state. These emissions are aggregated with the emissions from the light-duty sector and the port emissions to estimate emissions change factors at a 36km^2 grid.

Figure A2. Modeling Framework Diagram



A.4. Residential Buildings

A residential energy demand model was developed to predict the adoption and use of space-conditioning equipment in households in New York State in 2030. The novelty of the model is that, rather than using a representative household for all of New York, the model predicts the probability of heating appliance ownership for a broad range of households identified by a range of socioeconomic characteristics, as well as building and climate conditions. The model outputs used in this project include state-level electricity demand for heating and cooling and oil and gas demand for space and water heating and cooking, by PUMA.

This model implements policies such as heat pump subsidies and building shell efficiency standards for new construction and retrofits. We implement the fossil-fuel phaseout in the FTC as a floor on heat pump adoption. Below, the model design and methods for implementing these policies are described. More details about the methodology can be found in Poblete-Cazenave and Rao (2023).

A.4.1. Model Design

The space-conditioning model used here is an extension and adaptation of the space-conditioning module of the energy demand model first presented in Poblete-Cazenave and Pachauri (2021), an indirect utility maximization model, where households choose among different appliances and fuels to satisfy their energy needs. The model is estimated using simulation-based structural econometrics. The advantage of using simulation-based modeling for our purposes lies in the ability to use different data sets to create simulated households with characteristics obtained from multiple surveys, and to simulate future populations with additional assumptions on population drivers.

We start with the 73,149 household observations in New York in the American Community Survey as a base for the simulated households, which includes standard socioeconomic attributes. Additional attributes about the building condition, such as vintage and insulation, are imputed to these simulated households from the Residential Energy Consumption Survey (RECS 2015) using a common set of attributes between the two surveys. We project the stock of residences to 2030 using housing unit and income projections, assuming the new stock reflects the current distribution of household characteristics.

We separately use a multinomial discrete choice model to estimate the probability of adoption of different heating technologies based on the Northeast US sample of the American Housing Survey for 2015, which contains detailed information on heating equipment, buildings, and socioeconomic attributes. The predictors include socioeconomic household characteristics, including income, race, and age. Physical conditions include floorspace, building shell conditions (e.g., insulation), and building material type. We also included average building insulation R-values based on vintage, which were modeled as heating appliance efficiency penalty factors. Climate conditions (heating degree days) were differentiated by climate zones.

We combine the estimated coefficients from this discrete choice model with the parameter values of the simulated New York households in 2030 to obtain their probability of owning different heating appliances.

Since the surveys are representative at the PUMA spatial scale, we present results as appliance penetration rates and fuel consumption at the PUMA scale.

A.4.2. Energy Consumption

The model estimates fuel consumption for all heating appliances, as well as air-conditioning consumption for cooling and gas consumption for water heating and cooking, since these are required to determine air pollution estimates. Using simulation-based estimation methods on Residential Energy Consumption Survey data, the model obtains a distribution of energy consumption estimates for different appliances, which, joined with estimated sociodemographic effects, are used to calculate the utility-maximizing total energy consumption for each simulated household (Poblete-Cazenave and Pachauri 2021). We scale up the heat pump electricity consumption estimates for the Northeast, given that the underlying survey data reflect ownership largely in warmer areas (South and Mid-Atlantic). We use an engineering-based adjustment that takes into consideration building shell characteristics, climate-adjusted heat pump efficiency, and heating degree days to reflect theoretically expected consumption values. Finally, total county-level electricity consumption numbers are calibrated to match utilities' monthly consumption data in the base year for the state from NYSERDA, whereas gas consumption estimates are kept as obtained from the model, given their proximity to utilities' values.

A.4.3. Data

We use industry-standard rules of thumb for heating demand per square foot of floorspace for different climate zones. Hence, heat pump costs vary with climate and size of dwelling. For future technology cost and performance, we use EIA's Updated Buildings Sector Appliance and Equipment Costs and Efficiencies (2018). For heat pump cost and performance, we use the National Renewable Energy Laboratory's Electrification Futures Study (NREL 2017). The approximate average heat pump cost for the sample is $11,300.

For fuel prices, we use the high oil and gas supply case of EIA's Annual Energy Outlook (AEO) 2021.

For residential income growth, we use AEO 2021. For growth in residential units and climate zone designations, we use the New York State Climate Action Council Draft Scoping Plan, Integration Analysis Technical Supplement, Section I, Annex 1: Inputs and Assumptions.

For determining fossil fuel phaseout retirement schedules, we use the NYSERDA (2015) Residential Statewide Baseline Study, Volume 1, based on the Single Family and Tenant Survey, which has a breakdown of the share of households by age (Table 20).

For building shell R-values for future construction, we use the NYSERDA Stretch Codes. For existing building shell R-values by vintage, we use data from the National Renewable Energy Laboratory's ResStock model.

A.5. Ports

To estimate port emissions for the 2012 baseline and 2030 future scenarios, the team relied on a number of sources, notably past port emissions inventories for New York and New Jersey, to develop a model to extrapolate emissions as a function of cargo-handling equipment and intraterminal heavy-duty vehicle activity. For cargo handling, the team considered equipment such as terminal tractors, straddle carriers, forklifts, and other primary and ancillary equipment. The estimation process relies on two processes: first, service hours for each type of equipment are based on container movements and hourly use per year from inventory data, and then emissions factors per hour are used to estimate total yearly emissions for various pollutants. Similarly, for the heavy-duty vehicle component, inventory estimates of VMT at auto terminals, container terminals, and between terminal warehouses are then multiplied by corresponding heavy-duty port and yard trucks' emissions factors to estimate total emissions for the baseline. For 2030, the team estimated container movement growth and used this average growth factor to expand the count of cargo-handling equipment and heavy-duty vehicles' intraport activity and the associated emissions. Changes in emissions between 2012 and 2030 are estimated based on the literature and scaled as a function of the relationship between 2030 and 2012. For the FTC and RTC, based on experiences in California, the estimates assume a very high share of electrification for equipment and yard trucks. The drayage movements outside terminals are included in the truck flows modeled directly on the network. For drayage, the analyses follow the same assumptions of the general fleet.

The port's model considered the following facilities: Brooklyn Port Authority marine terminal, Port Jersey Port Authority marine terminal, Elizabeth Port Authority marine terminal, and the Howland Hook marine terminal. The analyses assume the same emissions factors and policies across these facilities, although some are in New Jersey.

Appendix B. Identifying Disadvantaged Communities

Appendix adapted from Krupnick et al. (2023)

For this report, we leveraged the Climate Justice Working Group community index to identify disadvantaged communities.[23] The index leverages 44 statewide indicators at the census tract level representing environmental burdens, climate change risks, population characteristics, and health vulnerabilities. The index is based on two main groups of statewide indicators at the census tract level:

- Environmental burdens and climate change risks (19 indicators)
    - potential pollution exposures
    - land use associated with historical discrimination or disinvestment
    - potential climate change risks
- Population characteristics and health vulnerabilities (25 indicators)
    - income
    - education and employment
    - race, ethnicity, and language
    - health impact and burdens
    - housing, energy, and communications

For each indicator, a percentile rank (0–100) is calculated for a given census tract across all census tracts in the state. The use of percentiles weakens the impact of extreme values for a given indicator and can represent a relative score for a census tract for that indicator.

The score for a given census tract was calculated as the product of its percentile rank in each of the two main groups, with some categories of indicators weighted more than others. The Climate Health Vulnerability Index (0–100) was calculated as the percentile rank of the final score for a given census tract among all census tracts in the state. This final score represents each census tract's relative state ranking.

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[23] A map and description of the criteria can be found here: **https://climate.ny.gov/Resources/Disadvantaged-Communities-Criteria**

Appendix C. Supplementary Methodologies

Appendix adapted from Krupnick et al. (2023)

C.1. Model Integration and Coordination

Our energy models operate independently of one another, but outputs of one may inform the inputs of another. For example, retail electricity prices may affect incentives to install an electric heat pump, or how much that heat pump is used. But how many heat pumps are operating also may affect electricity prices. Our model is not designed to find a general equilibrium solution, so we do our best to match electricity price and demand across model runs without that functionality. Our transportation models leveraged AEO electricity prices in the BAU case and increase prices proportional to the increases projected by the power sector for the policy cases. The residential model considers prices directly from the power sector model, iterating until it finds the appropriate combination of electricity price and residential demand. Electricity demands from residential and transportation sectors are passed to the power sector model for final emissions projections.

C.2. Methane

Decarbonization goals are defined in terms of carbon dioxide equivalent (CO_2e) rather than only CO_2. Of the many other greenhouse gases, the most important one, and the only one we track in this project, is methane. Since we are not modeling agriculture or waste dumps, our focus is solely on upstream methane emissions from oil and gas wells and how these emissions affect the accounting for meeting the decarbonization goals. We basically need two sets of information: the leak rate per final product consumed (gasoline, diesel, electric power) and the global warming potential of methane to CO_2 to transform the methane emissions into CO_2e. For the transportation sector, we used rates of 1.87 kilograms per gallon of diesel fuel and 1.79 kilograms per gallon of gasoline. We assume methane leakage of 0.000434 short tons per million Btu of natural gas use and 0.000174 short tons per million Btu of coal use, taken from Lenox (2013), a source that includes coal and whose natural gas leakage estimates have stood up well in light of more recent research about methane leakage associated with natural gas extraction, transportation, and processing. This methane leakage rate for natural gas implies that approximately 2.4 percent of natural gas leaks. In line with the CLCPA-related documentation, we use the 20-year global warming potential, which is 85 (IPCC 2014), except where otherwise noted.

Appendix D. Research Limitations

Appendix Adapted from Krupnick et al. (2023)

Several limitations to this study result from study design choices, modeling limitations, data limitations, and the like, indicating areas for further research.

Because of cost and time constraints in our modeling project, we model only a single policy year, 2030. This decision limits our ability to show the full effects of cap-trade-and-invest. Furthermore, we do not model all sources of New York emissions. Most notably, our current modeling does not incorporate commercial buildings or industrial facilities other than electric power generation. These two features of our analysis limit our ability to estimate the full effect of cap-trade-and invest implementation.

Because we do not cover all sectors, and the models we use operate independently of one another, our analysis should not be used to predict allowance prices in the NYCI market. However, we believe our work is still valuable in providing insight on how certain trading restrictions impact emissions reductions within sectors and at power-sector facilities. Our models share assumptions wherever possible to align findings across the models.

The independence of our sector models also limits our ability to directly estimate the CO_2 leakage impacts of facility-specific caps to other covered sectors in New York State (though we do observe power sector emissions leakages to out of state generation plants). Because the RTC has sector specific caps, leakage to other covered sectors in the New York program would not be a concern. However, if sector-specific caps were not in place, we would expect to see some transfer of emissions from the power sector to other covered sectors within the state when implementing facility-specific caps.

However, in an exploratory analysis we found this intersectoral leakage would likely not be a major issue with a wide range of scenarios. For example, when testing the sensitivity of CO_2 price to a cap, we found that adding the facility-specific caps from the RTC would put downward pressure on economy-wide carbon prices of less than five cents per ton. Alternatively, if we fix the carbon price, overall demand for allowances from the New York power sector does not significantly decline when facility-specific caps are added. In addition, for carbon prices fixed at higher than $5 (which is below the RGGI floor), our model estimates less than a 0.5 percent change in demand for allowances from the New York power sector. This number declines as carbon prices increase. Overall, these findings indicate that the facility-specific caps we model would mostly lead to a re-distribution of emissions across NY power plants, with limited leakage to other covered sectors in New York. A broader analysis with more sectors included could better identify what covered sectors might absorb these emissions. Despite those limitations, our research is an ambitious undertaking to understand the variable emissions and $PM_{2.5}$ pollution impact (see the next report) of cap-trade-and-invest polices in New York communities. This is just the first step in investigating this relationship, and many research opportunities remain, including studying the effects of additional pollutants.

Appendix E. Emissions Budget Methodology

Because we do not model all sectors, we need to estimate a unique 2030 emissions budget for the sectors we do model (electricity, residential buildings, and on-road transportation). We do this using the 2022 Statewide GHG Emissions Report[24]—New York's GHG inventory. We use the inventory to estimate emissions by sector for 1990, and also for the years for which we have readily available base-year historical emissions for each model (2012 for MHDV, 2016 for electricity, and 2019 for light-duty vehicles and residential buildings; we do not have 1990 estimates for any of the models). We also use the inventory to determine the percentage reductions in each base year and sector commensurate with the CLCPA mandate of a 40 percent reduction from 1990 levels by 2030. For example, according to the inventory, the state's residential building emissions grew from 1990 to 2019, so a 43 percent reduction from 2019 (our base year for the residential model) is needed to achieve a 40 percent reduction from 1990 levels. Conversely, electricity emissions have declined between 1990 and 2016 (our base year for the electricity model), so only a 12 percent reduction from 2016 is required to hit the target.

To create the preliminary emissions budget for our modeled sectors, we apply these tailored percentage reduction estimates to each of the sectoral base year emissions estimates. This approximates total emissions reductions needed if all modeled sectors achieved the 40 percent reduction from 1990 by 2030 target. Before finalizing, however, we slightly adjust this emissions budget downward using a scalar, to reflect the following assumptions:

1. We assume commercial building energy emissions (excluding industrial processes and product use, or IPPU) decline at a rate commensurate with the modeled residential sector.
2. We assume emissions from other unmodeled sectors change at rates estimated in the NY Integration Analysis (IA) Scenario 3,[25] according to the following logic.
    a. For sectors anticipated to be covered but unobligated by NYCI per the Scoping Plan and DEC comments during the NYCI rulemaking (agriculture, waste, and nonroad transportation, including aviation), we assume emissions will decline more slowly than 40 percent from 1990 by 2030 (a 19 percent reduction for waste and agriculture, and a 2 percent increase

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[24] The report can be accessed here: **https://www.dec.ny.gov/energy/99223.html**. Our calculations are based on the detailed emissions estimates located here: **https://data.ny.gov/Energy-Environment/Statewide-Greenhouse-Gas-Emissions-Beginning-1990/5i6e-asw6**

[25] We chose IA Scenario 3 because it represented stakeholder priorities. We also recognize that for most sectors of interest there were little to no differences across the IA policy scenarios.

for nonroad transportation—all compared with 2019[26] levels). We assume lower rates of decline because these sectors are not NYCI obligated, but we assume some rate of decline, expecting that the state will nonetheless implement some policies complementary to NYCI to help these sectors achieve reductions.

b. We assume industry (expected to be *obligated* under NYCI) may be subject to a more lenient cap because of EITE considerations. For industry, therefore, we assume less than the full 40 percent reduction pathway, but nonetheless some reductions in the context of complementary policy (14 percent reduction from 2019 levels).

c. For IPPU (37 percent reduction from 2019 levels), some of which may be obligated some not, and some also subject to EITE considerations, we apply the same middle-of-the road logic outlined above.

All of those assumptions lead to a 30 percent scalar, which essentially reflects an assumption that modeled sectors plus commercial buildings collectively will be required to cut emissions 30 percent more than if they were collectively held only to the 40 percent target—making up for sectors that are not expected to reduce emissions as quickly because they are either unobligated under NYCI or sheltered by EITE provisions. These estimates are subject to a variety of uncertainties, including how responsive unmodeled sectors are to the NYCI program and what the ultimate DEC-NYSERDA regulations look like.

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[26] The integration analysis uses 2020, but we apply the increases to 2019 in our estimates.

Appendix F. Complementary Polices

Table F1. Complementary Polices

Sector	Policy	BAU	Policy cases
Power	Clean energy standard	70% of electricity comes from clean energy sources, as defined in CLCPA	Same as BAU
Power	Distributed solar target	Mandates 10 GW solar installed by 2025	Same as BAU
Power	Battery storage target	Mandates 3 GW battery storage installed by 2030	Same as BAU
Power	Offshore wind target	Mandates 9 GW offshore wind installed by 2035	Same as BAU
Power	Transmission investment	Two new DC lines to be built in NYS: Clean Path and Champlain Hudson Power Express	Same as BAU
Power	Peaker plant policy	NYC peaker rule	Same as BAU
Residential	Heat pump subsidy	Existing NY Clean Heat program subsidy: Cold Climate Air Source $1,200 for climate zones 4 and 5, and the $1,500 Ground Source / Geothermal Heat Pump for households in climate zone 6	In addition to federal incentives, starting in 2025, these measures will take effect as NYS policy): (1) provide full heat pump cost subsidy to any household with 80% or lower of household median income; (2) provide 60 percent of the heat pump cost as subsidy to any household between 80% and 150% of household median income; (3) provide 40 percent of the heat pump cost as subsidy to any household above 150% of household median income.
Residential	Fossil fuel phase-out	No new buildings have fossil fuel systems	Same as BAU
Residential	Building standards	Current building standards	Same as BAU

Transportation (LDV)	Adopt California's Advanced Clean Cars 2 regulations	68% new LDV sales are PEV by 2030 (expected to require 100% light-duty ZEV sales by 2035)	Same as BAU
Transportation (LDV)	LDV rebate for ZEVs	(In addition to federal $7,500) $2,000 for new EVs (**NY Drive Clean Rebate**)	(In addition to federal $7,500) $5,000 for new EVs (Building off the NY Drive Clean Rebate)
Transportation (LDV)	Scrappage incentive	None	Subsidy amount (means tested): • $3000 per vehicle for households with income above 200% of federal poverty line • $5000 per vehicle for households with income below 200% of federal poverty line Eligible vehicles: any ICE vehicle 15-25 years old
Transportation (LDV)	Infrastructure investments	IRA/BIL subsidies	In addition to IRA/BIL subsidies, grants of up to $2,000 for Level 2 home charger installation
Transportation (MHDV)	ZEV sales mandate (Advanced Clean Trucks)	Class 2b and 3: 35% Class 4–6: 50% Class 7–8: long haul: 35%	Same as BAU
Transportation (MHDV)	MHDV rebate for ZEVs	**NY Truck Voucher Program**	Increased incentives above the NY Truck Voucher Program. Incentive levels vary by vehicle class and year.
Transportation (MHDV)	Investment in MHDV ZEV infrastructure	IRA/BIL subsidies	Grants up to $25k for each new MHDV for charging