New York's Affordable Energy Future

How Cap-and-Invest can provide billions to reinvest in local communities, lower energy bills for households

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About

WHO COMMISSIONED THIS REPORT?

This report was commissioned by Environmental Defense Fund, Earthjustice, and We Act for Environmental Justice.

WHO IS SWITCHBOX?

Switchbox is a nonprofit think tank that produces rigorous, accessible data on state climate policy for advocates, policymakers, & the public.

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Executive Summary

In 2023, New York Governor Kathy Hochul announced New York Cap-and-Invest (NYCI), a program intended to reduce total greenhouse gas (GHG) emissions across the state and scale up investments in an equitable climate and clean energy transition. New York has a long way to go to meet its legally-binding emissions reduction targets,[1] and a strong NYCI program would help the state make significant progress on these mandates while delivering public health and economic benefits to New Yorkers.

The NYCI program would set a declining cap on total GHG emissions and require major polluters to purchase permits for each ton of pollution they emit.

Putting a price on climate pollution would incentivize New York households and businesses to cut emissions: whether by consuming fewer fossil fuels, embracing energy efficiency, or switching to clean energy technologies.

A well-designed Cap-and-Invest program would catalyze an economy-wide shift towards clean energy and raise billions of dollars to be invested in New York communities. By law, this revenue must be invested in cutting pollution, ensuring an affordable transition to clean energy for New York households and small businesses, and creating jobs. At least 35% of this investment must be directed to communities overburdened by pollution and worsening climate impacts, defined as disadvantaged communities under state law.

NYCI investments could deliver transformative benefits for New York communities. This report examines how program revenue could benefit New Yorkers by putting money back in their pockets, investing in community-led priorities, and helping families switch off fossil fuels—saving them money on their energy bills and accelerating New York's transition to clean energy.

Crucially, we show that as the ambition of the NYCI program increases—assessed by comparing scenarios with higher prices on climate pollution, and therefore larger revenues—the benefits to New Yorkers grow, *while successfully continuing to insulate*

1 The NYS Climate Leadership and Community Protection Act (S6599 / A8429) (2019) set targets of 40% reduction from 1990 levels by 2030, 85% reduction by 2050.

most low- and moderate-income households from any increased costs. Put another way, with smart reinvestment, New York regulators can be confident that a strong NYCI program will also be an affordable one.

This report models the impacts of potential rebates, heat pump incentives, weatherization subsidies, and place-based investments. These programs represent key components of a high-level *spending scenario*, illustrating one of many ways the state could direct investments that deliver concrete benefits while keeping NYCI affordable.

In short, we find that NYCI investments can drive decarbonization, support community economic development, and save households money on energy bills—and that higher carbon pollution prices significantly enhance these benefits without burdening economically vulnerable New Yorkers.

SPENDING SCENARIO

In the revenue projections examined by this report, NYCI would raise a total of between $61 - $126 billion over the first 11 years of the program. [2]

Our spending scenario would allocate:

- 23% of this revenue, or $14.3 - $29.4 billion, to residential building decarbonization: incentives for households to install electric heat pumps, as well as any weatherization or home repairs required for those households to save money on their energy bills going forward.
- 2%, or $1.5 - $3 billion, to a community-led, place-based investment program that would provide tangible benefits to disadvantaged communities.
- 40%, or $24.4 - $50.4 billion, to a rebate program that puts money directly in the hands of New Yorkers to offset impacts from rising fossil fuel prices under NYCI.

2 Average annual revenue of between $5.5 - $11.4 billion a year. The amount depends on what price ceiling the state sets on allowances under NYCI.

The scenario would also direct funds to the following programs,[3] though we do not model their impact in-depth:

- 13%, or $8 - $16.5 billion, to transportation decarbonization
- 9%, or $5.4 - $11.1, to commercial building decarbonization
- 5%, or $3.2 - $6.7 billion, to clean energy workforce training

FINDINGS

Our evaluation of this spending scenario reveals that between 2025 and 2035, NYCI revenue could:

- Help **46%** of New York households upgrade to electric heat pumps by 2035, allowing the median household to save between $66.95 and $85.22 in energy costs per month, or between **$803** and **$1,022** per year.[4]
- Provide $30 million grants to **50 to 100** disadvantaged communities to invest in community-directed projects, such as green affordable housing, rooftop solar, electric buses, and bike lanes.
- Provide direct rebates to **83%** of New York households, while fully insulating **46%** of households from any increased energy costs under NYCI. A further **25 - 40%** of households would pay between 0 and $40 extra a month.
- Via direct rebates, fully insulate **78%** of low-income, **57%** of moderate-income, and **20%** of medium-income households from any increased energy costs.

In addition, we find that with a higher price on climate pollution, NYCI could help **twice** as many New Yorkers adopt money-saving clean energy technologies, while ensuring that 70% of low- and moderate-income households are equally well off, if not better off, in terms of energy costs.

3 The final 8% of revenue would be allocated to commercial rebates and administering the NYCI program.

4 If the state sets the "high" price ceiling on allowances examined in this report. Under the lower price ceiling, NYCI would generate 32% of the funding needed for this incentive program.

Background

HOW CAP-AND-INVEST WORKS

Cap-and-Invest places a total limit, or cap, on all greenhouse gas emissions in New York State.

By law, the state is legally required to reduce emission to 40% below 1990 levels by 2030, and 85% below by 2050.[5] To achieve these targets, the cap would need to decline steadily year by year.

While the state has yet to finalize a plan, scenarios modeled by NYSERDA,[6] the state's clean energy agency, include a gradual lowering of the cap during the first few years of the program, followed by a steeper decrease as time ticks towards New York's mandated pollution targets.

Under the state's current NYCI proposal, any entity defined as a large-scale source of emissions, or a large-scale distributor of heating and transportation fuels, will be required to purchase "allowances" from the state, essentially permits to emit greenhouse gases. Every year, the state would sell a number of allowances equal to the tons of climate pollution under that year's cap.

Note

Impacted sectors will likely include residential and commercial buildings, transportation (excluding aviation), industry (including paper, cement, and steel production), waste, and oil and gas.

The electricity sector will likely be excluded from NYCI, as it already participates in a multi-state cap-and-trade system called the Regional Greenhouse Gas Initiative (RGGI).

Over time, the cost of these allowances would rise. This would create an incentive for large polluters and fuel consumers to adopt clean energy technologies, which would reduce emissions.

5 See NYS Climate Leadership and Community Protection Act (S6599 / A8429) (2019).

6 See NYSERDA's NYCI Pre-Proposal Outline (NYSERDA 2023).

But there's an additional way that NYCI could help decarbonize New York, which is the focus of this report: by generating billions of dollars of revenue a year that the state government could invest in mitigation efforts.

How much revenue NYCI generates depends on how high the state allows the price of allowances to go.

ALLOWANCE PRICE SCENARIOS

The state would sell allowances through an auction, which would set an initial price for each pollution permit.[7]

In theory, as the cap declines, the state would sell fewer allowances, driving up their cost. The higher the cost, the more households and businesses would decarbonize, reducing emissions in line with the state's targets.

In practice, rather than allowing the market to set the price of allowances, the state is likely to control the price by using a **price ceiling**.

Note

Price ceilings provide certainty to businesses about their maximum compliance costs, prevent extreme spikes in fossil fuel prices that could harm the economy, and can help maintain political support for cap-and-trade programs.

However, they have the effect of weakening the cap: if the auction price ended up being higher than the price ceiling for a given year, the state would sell unlimited allowances at the ceiling price, resulting in more allowances sold than the cap would otherwise allow.

Price ceilings therefore sacrifice the state's ability to control the *level* of climate pollution in exchange for the ability to control the *price* of climate pollution.[8] A declining cap would thus be unable to single-handedly decarbonize New York by 2050, and Cap-and-Invest would need to be paired with complementary policies.[9]

7 If New York decides to allow trading, there will also be a secondary market with fluctuating prices for allowances.

8 This is why economists often describe a price ceiling as converting cap-and-trade into a carbon tax at that price point.

9 As documented in the book Making Climate Policy Work (Cullenward and Victor 2020), this is true of all real-world cap-and-trade systems.

In a recent modeling exercise, NYSERDA examined a range of price ceilings and found that the true market clearing price of allowances in New York State would exceed all of them.[10] In all these scenarios, then, the price ceiling would determine the allowance price, effectively allowing the state to directly control the price of carbon in New York.

10 See NYSERDA NYCI Pre-Proposal (NYSERDA 2023).

Following NYSERDA's preliminary analysis of NYCI, this report evaluates a high and low price ceiling scenario:

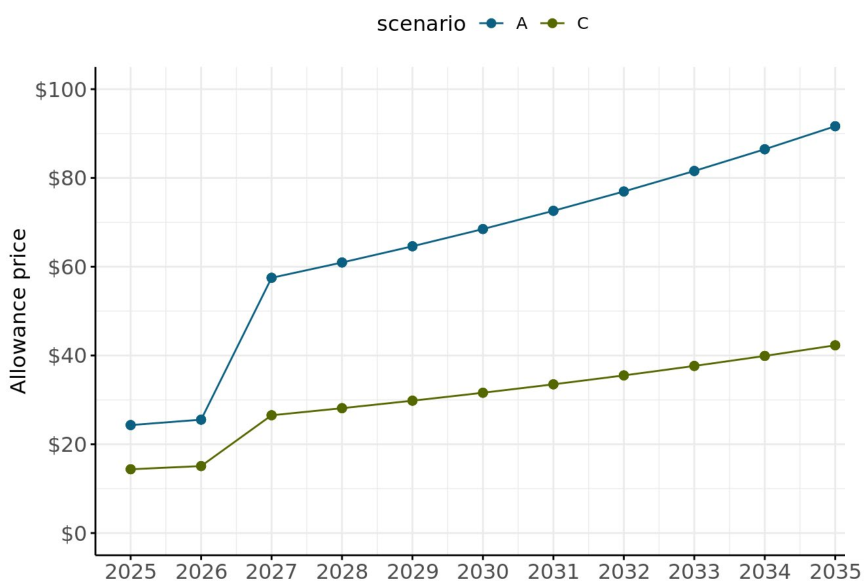


Figure 1: Allowance price scenario A and C

- **scenario A** would set a $24 per-unit ceiling on allowances in 2025, rising to $26 in 2026, $58 in 2027, and by 6% annually thereafter.
- **scenario C** would set a $14 per-unit ceiling on allowances in 2025, rising to $15 in 2026, $27 in 2027, and by 6% annually thereafter.

Allowance price ceilings would continue to escalate thereafter, though NYSERDA didn't model them.

REVENUE SCENARIOS

The amount of revenue generated by NYCI depends on the allowance price.

Because New York State is likely to contain costs through a price ceiling, we can forecast the revenue that NYCI would produce, year by year, under our high and low price ceiling scenarios (Figure 2).

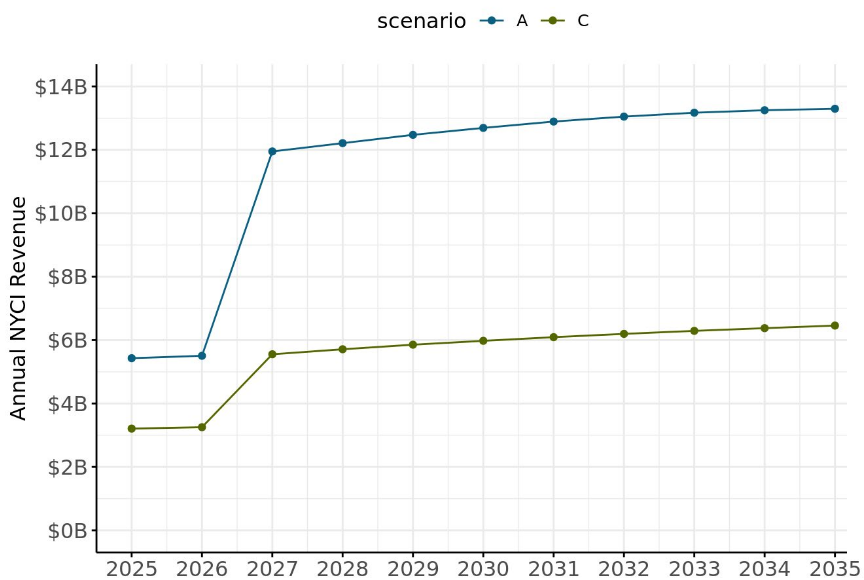


Figure 2: Estimated NYCI annual revenue under price scenario A and C.

In both scenarios, revenues jump between 2026 and 2027 due to a corresponding jump in the price ceilings. After 2027, revenues grow slowly because the total number of allowances decreases faster than the per-allowance price increases.

Under scenario C, which places a lower ceiling on allowance prices, thereby limiting the program's revenue, the state will generate an estimated **$3.2** billion in 2025, rising to $6.5 billion in 2035.

Under scenario A, which prices allowances higher and generates more revenue, the program's revenue jumps to $5.4 billion in the first year of the program, increasing to $13 billion after 11 years.

To put these figures in context, NYSERDA has estimated that decarbonizing the state will cost $11 billion in 2030, counting both private and public spending.[11]

In 2030, the state would collect $6 billion in NYCI revenue under scenario C, and $13 billion under scenario A.

These sums would cover 54 - 115% of NYSERDA's 2030 cost estimate and are equivalent to 3 - 5% of New York State's $237 billion 2025 budget.[12]

11 According to p. 131 of the NY Climate Action Scoping Plan (NYS Climate Action Council 2022).

12 See Gov. Hochul's press release on FY25 budget (NYS 2024)

PROPOSED SPENDING SCENARIO

How might the state spend this revenue to accelerate decarbonization while delivering benefits directly to households and communities?

State law provides broad guidelines on how NYCI revenue can be spent. Specifically:

- 30% of the revenue must be used to help reduce potential increased energy costs for consumers, which the state will likely provide via direct rebates.[13]
- The rest of the proceeds must be invested in programs that aid New York's transition to a less carbon-intensive economy.[14]
- At least 35% of all program spending must go to geographically-designated disadvantaged communities.[15]

Within that framework, many different spending packages are nevertheless possible. Spending the revenue well, however, could have a transformative impact on the state.

To illustrate this potential, our spending scenario focuses on community-led infrastructure projects and direct benefits for households, in the form of financial incentives to purchase heat pumps and weatherize homes. In Section 3.1.4, we model the household bill savings that would result from these projects.

Our spending scenario allocates a set percentage of annual NYCI revenues to the programs in Table 1.

The dollar amount received by each program would depend on yearly NYCI revenue collected by the state, which would depend in turn on the price ceiling scenario.

The following diagram shows the funding each program would receive in total, between 2025 and 2035, under the high and low scenarios:

13 As codified in the State of New York's Public Authorities Law, Article 8, title 9, §1854 (State of New York 2023).

14 *ibid.*

15 As codified in the NYS Climate Leadership and Community Protection Act (S6599 / A8429) (2019).

Program	Percent of Revenue
Workforce Development	5%
Transportation	13%
Commercial Decarbonization	9%
Residential Decarbonization	23%
Place-based Investments	2%
Direct Rebates	40%

Table 1: Revenue allocation by program under proposed spending package.

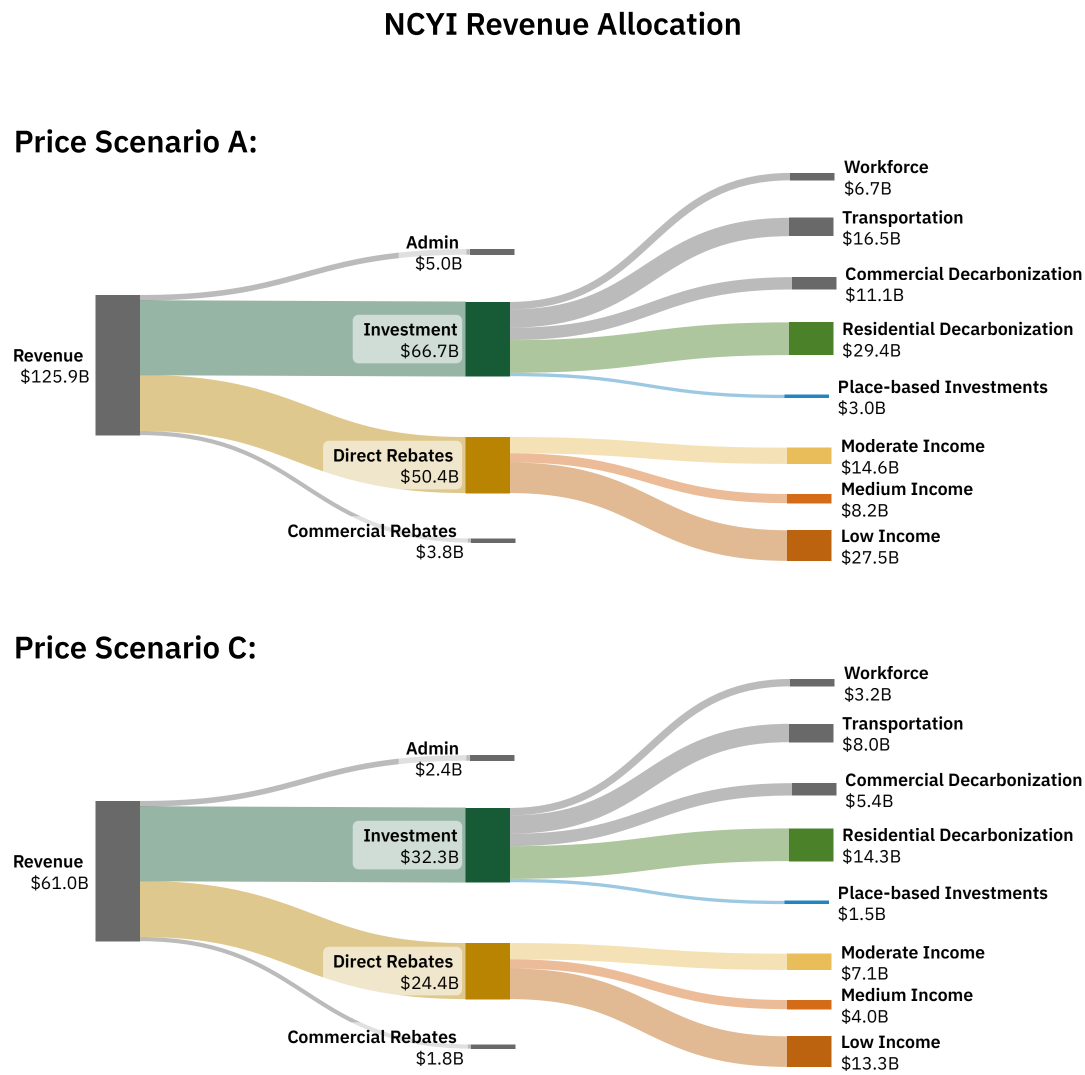


Figure 4: Possible allocation of NYCI revenue under price scenario A and C. Values reflect the total revenue from 2025 - 2035 adjusted to 2024 USD.

The programs in this package are based on investments modeled in NYSERDA's preliminary analysis of NYCI[16] and represent a balanced decarbonization investment portfolio.

This report focuses on the **residential decarbonization** (Section 3.1), **place-based investments** (Section 3.2), and **direct rebate** (Section 3.3) programs, modeling the impact that these programs could have on households and communities.

Despite their importance to the state's emission reduction goals, we do not closely evaluate the **workforce development**, **transportation**, or **commercial decarbonization** programs. We include them for completeness and to realistically constrain the revenue that could be allocated to our focus programs.

16 See NYSERDA NYCI Pre-Proposal (NYSERDA 2023).

Findings

RESIDENTIAL DECARBONIZATION

The building sector presents the state's largest decarbonization challenge, but also the biggest opportunity to improve the lives of everyday New Yorkers by investing in clean energy and cutting emissions.

Residential and commercial buildings combined make up the state's highest-emitting sector, accounting for 31% of all greenhouse gas emissions.[17] To achieve net-zero emissions by 2050, as mandated by the CLCPA, New York will have to virtually eliminate emissions from buildings. Doing so will require retrofitting nearly every building in the state: electrifying their heating and further weatherizing millions of units.[18]

These retrofits offer the most direct and equitable way to deliver benefits from decarbonization to all New Yorkers.

Direct, because these projects would produce tangible improvements to a household's quality of life: more comfortable homes with lower energy bills.

Equitable, because nearly all households could benefit—especially the 1 in 4 that are currently energy-burdened[19]—and nearly all households could benefit at the same rate, regardless of income.[20]

We propose that investment take the form of a generous incentive program that would lower the upfront cost of electric heat pumps, weatherization, and health and safety repairs.

Today, **86%** of New York households could lower their energy bills by installing electric heat pumps—though some would need to weatherize their homes first in order to achieve savings.

These households would enjoy cheaper energy bills immediately, and avoid any increased costs associated either with NYCI or with volatile fossil fuel prices.

The primary obstacle to households taking advantage of this opportunity is the high upfront costs of heat pumps, weatherization, and repairs.

17 As documented in the Department of Environmental Conservation's 2023 GHG Emissions Report (DEC 2023).

18 See NYSERDA's Integration Analysis (E3 2022).

19 As documented in Switchbox's report, NY HEAT & Energy Affordability (Shron and Velez 2024a).

20 Unlike EVs, which at present are purchased largely by households that can afford new cars.

Weatherization
reducing heat loss in a building by sealing air leaks and insulating attics, walls, and basements.

While the state, utilities, and the federal government currently offer incentives that cover some of these upfront costs,[21] these subsidies are not high enough to entice everyone to make the switch when the time comes to replace their boiler or furnace. To drive up adoption—in order to cut emissions and insulate households from rising fuel prices—incentives would need to be more generous.

Heat pumps and weatherization could lower bills and increase comfort for nearly all New Yorkers. Through a well-designed incentive program, NYCI revenue could help millions of households unlock these savings by pushing down the upfront costs of those upgrades.

21 Namely, the Clean Heat and Empower+ programs under New Efficiency: New York, and federal tax credits under the Inflation Reduction Act. See Section 3.1.8 for details.

Who can benefit from heat pumps?

Previous research by Switchbox has shown that the vast majority of New York households could lower their energy bills by installing heat pumps—though 51% of households would also need to weatherize their homes before experiencing savings.[22]

Figure 5 breaks down the percentage of households in New York State that would save money by switching to heat pumps **today**, regardless of whether their current HVAC system requires replacement.

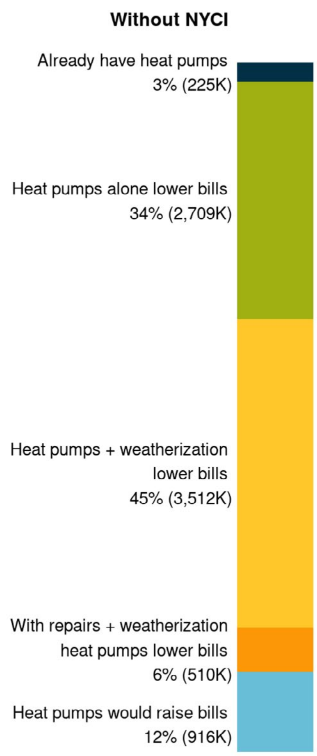


Figure 5: NYS households, classified by upgrades needed to save money by installing heat pumps today.

Only a fraction of New York households would actually have occasion to switch to heat pumps today, given the age of their boiler or furnace. But if they did, Figure 5 shows us what upgrades they would need to ensure lower energy bills upon switching:

- **Already have heat pumps**: Approximately **3%** of New York households have already installed heat pumps.
- **Heat pumps alone lower bills**: Roughly **34%** of households could see their bills drop by switching to heat pumps alone, no further upgrades required.

22 Refer to Switchbox's Bucks for Boilers report (Shron and Velez 2024b).

- **Heat pumps + weatherization lower bills**: A further **45%** could see savings if they also weatherized their homes.
- **With repairs + weatherization, heat pumps lower bills**: Another **6%** of units would require repair and remediation of mold, asbestos, roof leaks, and other health and safety issues before being able to weatherize.
- **Heat pumps would raise bills**: For **12%** of households, switching to a heat pump would not lower their bills, even combined with weatherization, *assuming current energy prices*. These tend to be newer, well-insulated homes with highly efficient furnaces and boilers.

However, by raising the cost of fossil fuels, NYCI moves some households out of the no-savings category into the category who would save money by switching to a heat pump and weatherizing (Figure 6):

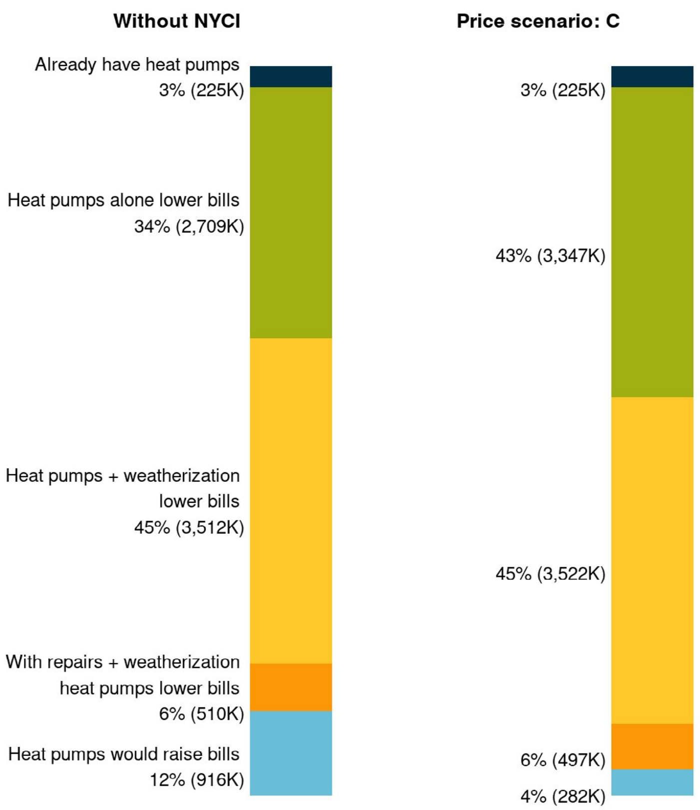


Figure 6: NYS households, classified by upgrades needed to save money by installing heat pumps, today and under NYCI scenario C.

Higher fuel costs would also allow some households to save money with heat pumps without needing to weatherize first.

These two trends are more pronounced under price ceiling scenario A versus scenario C. The higher the allowance price, the more attractive heat pumps become compared to fossil heat (Figure 7):

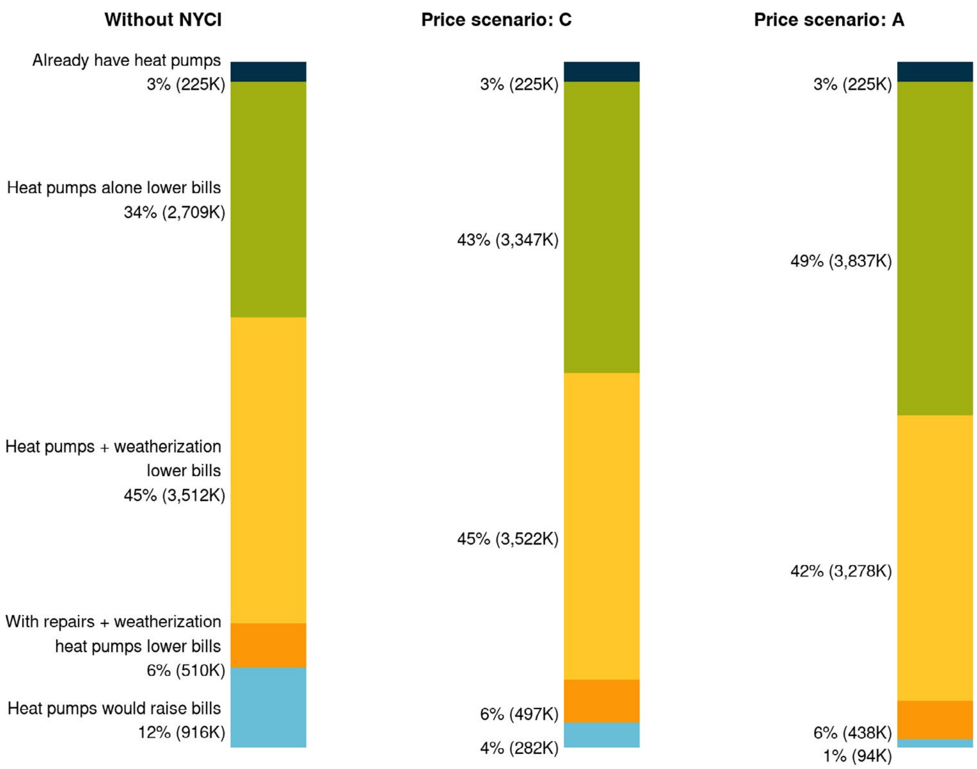


Figure 7: NYS households, classified by upgrades needed to save money by installing heat pumps, today and under NYCI scenarios C & A

Under scenario C, the percentage of New York households that would not experience savings drops from 12%% to 4%%. Meaning **96%** of homes that need to electrify by 2050 would lower their bills by doing so.

Under scenario A, **99%** of New York's yet-to-be-electrified households would save by switching.

Ultimately, the task of building decarbonization becomes easier as price ceilings go up. Not only do higher allowance prices generate the revenue needed for more generous heat pump and weatherization incentives, but by raising the price of fossil fuels, they make switching more attractive.

The need for upfront subsidies

The vast majority of households in New York State can, over time, achieve savings through heat pumps and weatherization. NYCI's incentives and impact on fuel prices make it so that more homes will save by switching, and increasing the size of those savings.

While the vast majority of households in New York State could enjoy lower energy bills and more comfortable homes by switching to heat pumps and weatherizing, the upfront costs of doing so can be prohibitive (Figure 8):

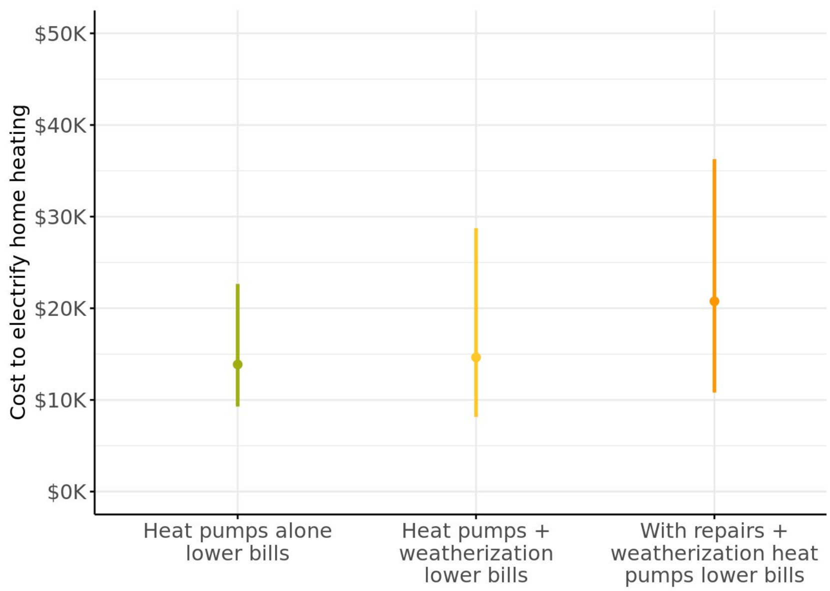


Figure 8: Cost of heat pumps (above replacing existing heating system) weatherization, and repairs. Range reflects the middle two-thirds of cost distribution, dots indicate the median cost.

For a household replacing their failing boiler or furnace, the median cost to do so with a heat pump is **$13,867** more than the cost of a new boiler.

A household that also needs weatherization to achieve savings would need to pay a median cost of **$14,639** to do both.

If the home also needs repairs, the average cost for all three, over a simple boiler or furnace replacement, would be **$20,761.**[23]

Not all households will be able to afford these upfront costs. Despite the prospect of ongoing savings if they make the upgrade, they may lack the needed cash or be unable to secure financing.

23 These costs estimates are based on real-world prices for both equipment and labor gathered from a multitude of sources. See appendix (Section 4.5.4) for details.

Some households may simply not feel comfortable with making such a large expenditure, especially if the purchase decision is made under the duress of their heater dying out in the middle of winter.

In addition, payback period—the time it takes to recoup these upfront costs from energy savings—is quite long.

NYSERDA estimates that households will make the switch if they can pay back their out-of-pocket upfront costs through bill savings within six years of purchasing a heat pump.[24] Based on discussions with advocacy groups focused on low-income households, we believe that lower-income households would need a shorter payback period of three years to make the switch to heat pumps enticing and affordable.

Why do long payback periods matter? Uncertainty around long-term fuel prices can make savings less certain. Homeowners may not be living in the house long enough to recoup their investment. Status quo bias—the preference for keeping things the way they are—and present bias—the tendency to discount future rewards—might lead households to avoid switching, even if doing so would benefit them financially.

Even with fuel prices rising under NYCI, most households would still experience unacceptably long payback periods. Under scenario A, where fuel prices are expected to rise more, only **11%** of households that switch to heat pumps would recoup their upfront costs within six years, for higher-income households, and three years for low- and moderate-income households. In other words, for most households, the savings are too small to justify the upfront costs.

These two obstacles—high upfront costs and long payback periods—threaten New York's ability to accelerate heat pump adoption and eliminate building sector emissions by 2050.

NYSERDA's decarbonization pathways analysis demonstrates that the only way to eliminate building sector emissions by mid-century is for all boilers and furnaces that die after 2030 to be replaced by electric heating, predominantly heat pumps.[25]

Achieving this 100% replacement rate by 2030 will likely require generous incentives that push down the upfront costs of heat pumps and weatherization, and these incentives could

24 This payback period is derived from an internal rate of return in NYSERDA's Heat Pumps Potential for Energy Savings report (NYSERDA 2014).

25 See NYSERDA's Integration Analysis (E3 2022).

be funded by NYCI revenue. By reducing sticker shock and improving payback periods, generous subsidies would nudge more households to choose heat pumps, not fossil fuels, when it's time to replace their existing heating system.

Incentive program design

To estimate the bill savings that New York households could enjoy from installing heat pumps—and the cost to the state of subsidizing these installations—we propose a simplified program of heat pump and weatherization incentives.

> **Warning**
>
> Our program design is not intended as a directly adoptable policy. It is meant to be illustrative, allowing us to estimate the potential benefits and costs of using NYCI revenues to electrify homes.

Our program design makes a number of assumptions about when and how households would switch to heat pumps:

- **No early retirement**: We assume that households will only switch to heat pumps when their current boiler or furnace dies. In other words, households will not retire their current systems until they have to.
- **Savings required**: Households will only adopt heat pumps if doing so, either alone or with some combination of weatherization and home repairs, lowers their operating costs. In our simulation, households that cannot see savings even with weatherization do not switch to heat pumps.
- **Target payback period satisfied**: Households will only adopt heat pumps if their out-of-pocket upfront costs, after incentives are applied, would be paid back by savings within six years for middle-and high-income households. For low- and moderate-income households, a three-year payback period is required, in recognition of the higher barriers and lower access to capital faced by this population.

- **Out-of-pocket costs are not an obstacle**: We assume that households can afford to pay any remaining out-of-pocket cost, after incentives are applied, assuming these target payback periods are satisfied. In reality, despite having much of the upfront cost covered by incentives, lower-income households may still lack the cash or access to financing.
- **Renters upgrade too**: We assume renter-occupied homes switch to heat pumps when their heating system dies (assuming they can save money by doing so). In reality, landlords may not be incentivized to upgrade if tenants pay their own energy bills.
- **Apartments act independently**: We also model households in multi-family buildings as making independent HVAC investment decisions—in other words, we assume individual apartment units within a building are electrified at different times. In reality, households in multi-family buildings need to coordinate such decisions.

Our simulation, which covers the first decade of the program, has the following steps:

1. **Eligible households:** We simulate the percentage of households across New York State that will need to replace their boiler and furnace every year between 2025 and 2035.
2. **Upgrade packages:** For each of these eligible households, we identify the specific upgrades they need to achieve lower bills with cold-climate air source heat pumps without any fossil fuel backup.[26] As discussed in Section 3.1.1, some dwellings can save immediately once they electrify. Others must weatherize first, and a subset of these need repairs before they can weatherize. The rest are unable to achieve savings—even with weatherization. These stay on fossil fuels, the rest receive an upgrade.
3. **Bill savings:** For each household that upgrades, we calculate the precise monthly bill savings that result, using building energy simulations and current utility rates. We assume that utility rates remain fixed for the duration of the study.[27] For NYCI price impacts, we assume that the entire price of purchased allowances will be passed on to consumers.

26 In practice, some percentage of households would opt to install ground source heat pumps. While these have higher upfront costs than air source, they also have lower operating costs, likely reducing the need for many homes to weatherize before they see savings.

27 This is a conservative assumption, as New York's gas utilities have raised rates significantly in recent years, and without reform, are expected to continue doing so. See BDC's Future of Gas in New York State report (Walsh and Bloomberg 2023).

4. **Upfront costs:** Next, we calculate the upfront cost of the household's upgrade package, using real-world installation costs. We define upfront costs as any expenses—from purchasing and installing a heat pump, weatherizing or repairing a home—that exceed what it would cost to simply buy and install a new furnace or boiler. We assume that households with existing forced-air systems are able to repurpose them for their heat pumps, and that households without them install mini-splits instead of adding ductwork.
5. **Effective payback period:** To calculate the household's effective payback period, we divide the upfront cost by the monthly bill savings.
6. **Area Median Income percentage:** We determine the household's Area Median Income (AMI) percentage by comparing their income to the AMI of same-sized households in their county.
7. **Target payback period:** Using the table below, we use the household's AMI percentage to identify the target payback period appropriate to their income level.
8. **Subsidy calculation:** If the household's effective payback period is longer than the target, then we increase the upfront subsidy until the target is achieved. For instance, a medium-income household might take 12 years to pay back the upgrades they need to electrify with savings. In order for the household to enjoy the savings after only six years, our subsidy program would cut the upfront cost in half.

It's worth noting that our proposed scheme differs significantly from traditional incentive programs. Our subsidy is based entirely on achieving each household's (income-appropriate) target payback period, regardless of which precise upgrades (i.e. heat pump, weatherization, repairs) they need to achieve bill savings.

In practice, incentive programs typically cover a certain percentage of the cost of specific upgrades (heat pumps or weatherization), up to a dollar-amount cap, and the percentage depends on the household's income level. Under NYSERDA's Empower+ program, for instance, the state pays for half the cost of weath-

Income level	Definition	Target payback period
Low	0 - 60% AMI	3 years
Moderate	60 - 100% AMI	3 years
Medium	100 - 180% AMI	6 years
High	180%+ AMI	6 years

Table 2: Target payback periods used for calculating incentive levels, by income level

erization-only projects undertaken by moderate-income households (those that earn 60 - 80% of AMI), up to $5,000.[28]

We encourage the state to design incentive programs that achieve post-installation savings and attractive payback periods, since these will be critical for sustained heat pump adoption. In practice, however, we recognize that subsidies are unlikely to be calculated using target payback periods for each individual retrofit project.

Warning

There are limitations to our simulation.

- We assume everyone who can achieve their target payback period by switching to a heat pump will do so. The reality is that some people will simply opt to replace their ailing boiler or furnace with a new one, even with generous incentives. Landlords, for instance, always pay for HVAC equipment but not always for their tenants' monthly energy bills. When they don't stand to benefit from bill reductions, landlords are likely to choose fossil fuel replacements, since new boilers and furnaces are currently cheaper than heat pumps. This is why the New York State's 2022 Climate Scoping Plan calls for all-electric appliances mandates: requiring most heating system replacements to be electric, starting in 2030. [29]
- Most furnace and boiler replacements happen under duress, often in the middle of winter. In practice, the state will need to take steps to ensure households switch to heat pumps before their heaters die, and potentially lend out temporary replacement boilers and furnaces to those who don't.

While New York State will need to solve these and other obstacles to successfully implement any incentive program at scale, these details are out of scope for our analysis, which focuses on the financial costs and benefits that would result from successful implementation.

28 Program eligiblity rules are from the Empower+ website (NYSERDA 2024.)

29 From p. 11 of NY's Climate Scoping Plan (NYS Climate Action Council 2022).

Impact of subsidies

If New York State implemented our proposed incentive program, how much money would electrifying households save?

Figure 9 shows the average monthly reduction in energy bills that households across the state would experience today, pre-NYCI, if they installed heat pumps, with weatherization and repairs as needed.[30]

30 In reality, savings would fluctuate from month to month and would be higher during the heating season than the summer. This histogram shows the average of these monthly savings.

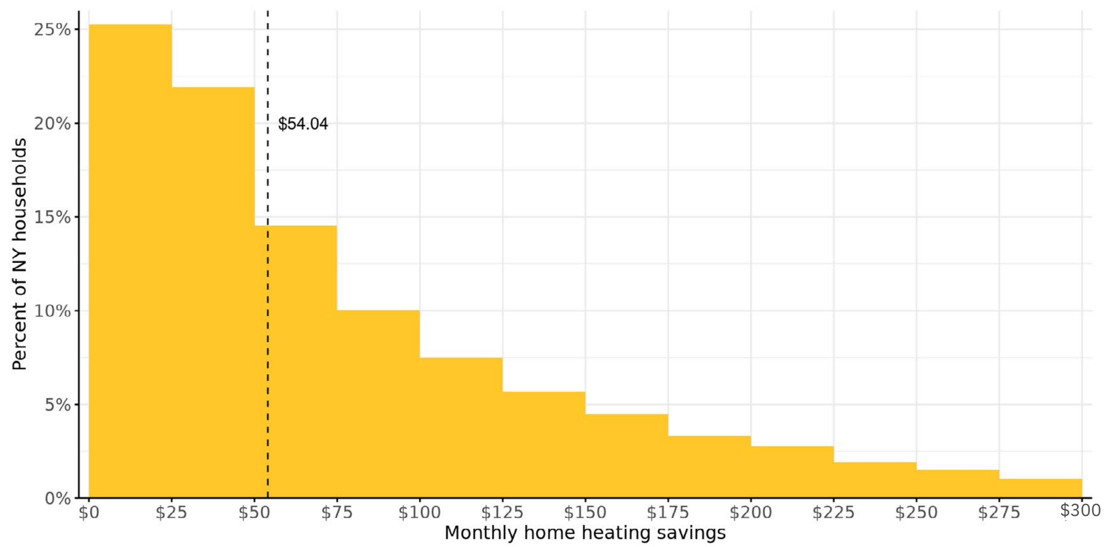


Figure 9: Mean monthly savings in operating costs after switching to a heat pump. Dashed black line represents the median of average monthly savings. Does not include upfront costs or rebates. Savings only shown for homes that would save by electrifying.

Households across the state would experience a wide range of post-upgrade bill savings. Homes moving away from propane or heating oil, for instance, would save more than those moving away from natural gas because delivered fuels are more expensive.

The median monthly savings is **$54**: half of households save less per month on average across the year, and half would save more.[31]

31 Households with savings greater than $300 a month were removed before calculating this median.

Note that our analysis assumes households would only switch if it's possible for them to achieve savings, potentially with the help of weatherization. In other words, the 12% of households with no path to electrifying-with-savings are excluded from Figure 9.

How would increasing fossil fuel prices under NYCI affect these savings?

Figure 10 shows how those monthly savings would change under price scenarios C and A.

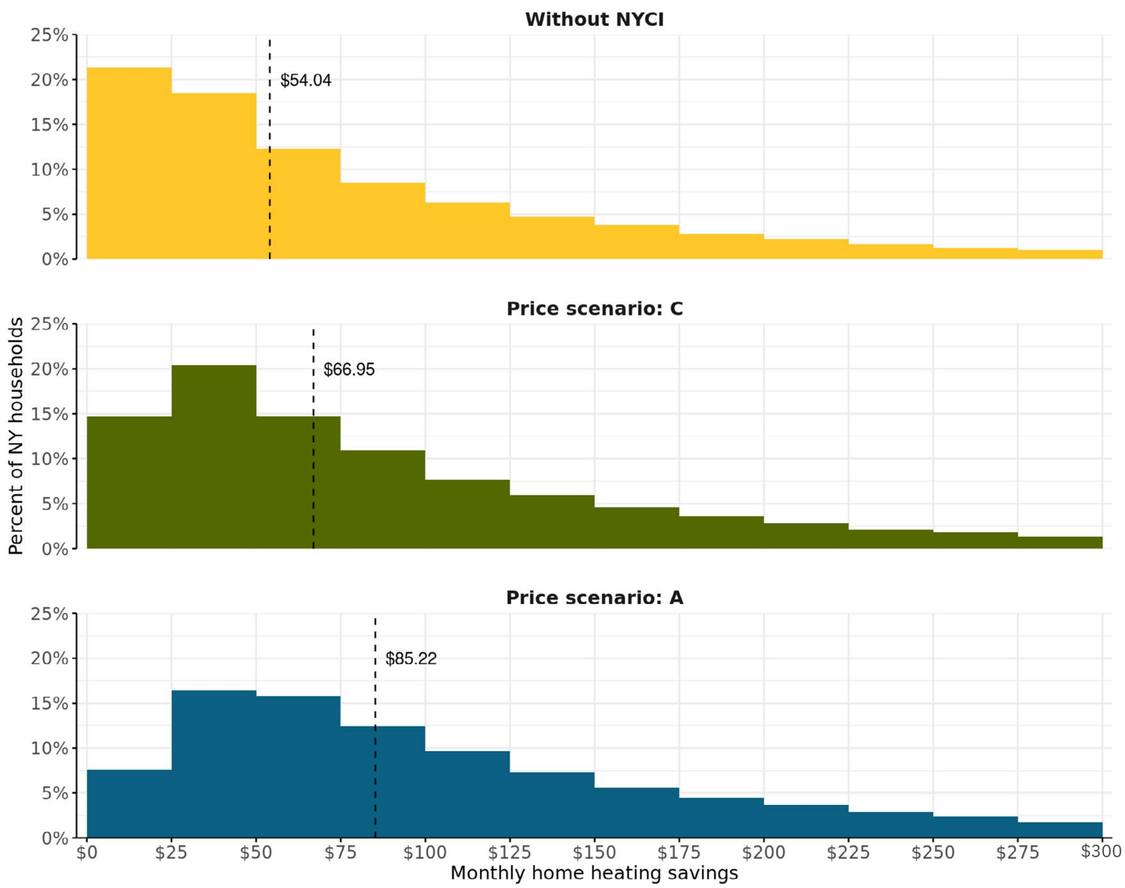


Figure 10: Mean monthly savings in operating costs after switching to a heat pump. Dashed black lines represent the median of average monthly savings. Savings only shown for homes that would save by electrifying.

Before NYCI, the vast majority of people would save money on their monthly energy bills by switching to a heat pump. Of those households that would not save money prior to NYCI, 69% would under scenario C, and 90% under scenario A.

As fuel prices rise, so would savings: the median savings would grow to **$66.95** under scenario C, and **$85.22** under scenario A.

Why does this happen?

Because the state appears poised to exclude the power sector, electricity prices would not change under NYCI.[32] The price of natural gas and delivered fuels would rise, however. Heating a

32 Indeed, New York's power sector already participates in a cap-and-trade system, the Regional Greenhouse Gas Initiative, so today's electricity costs already reflect a carbon price.

building with fossil fuels would get more expensive, while the cost of heating it with a heat pump, already lower thanks to the upgrade package, would stay fixed. The higher the allowance price, the wider the gap in operating costs.

Crucially, these savings produced by heat pumps and weatherization retrofits under NYCI are not primarily caused by the program making fossil fuels more expensive. With the right upgrades, **86%** of New York households would save money on their energy bills prior to NYCI by adopting these technologies.

For households that could already save by switching, NYCI would simply increase their savings, making them more likely to do so. Approximately **69%** of households that would lose money by switching today would instead see savings under scenario C, and **90%** under scenario A.

How do these savings break down by income?

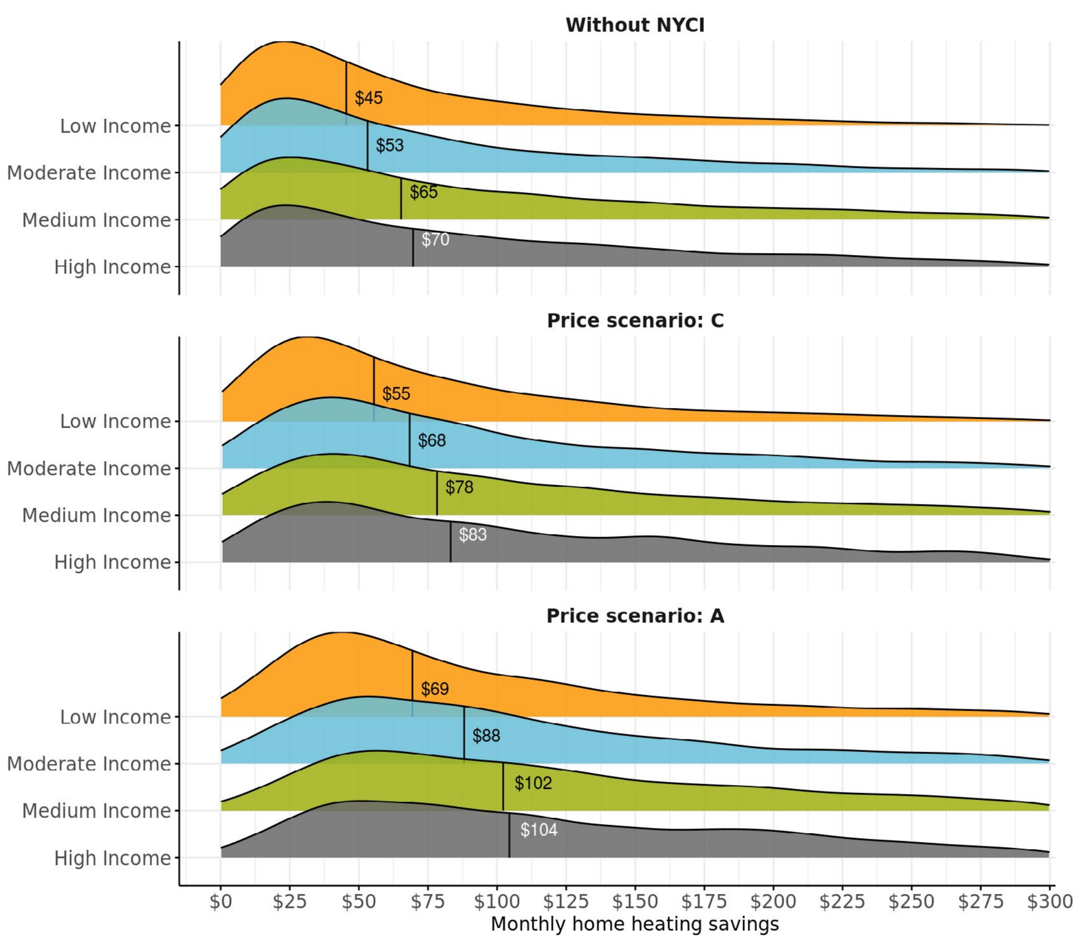


Figure 11: Mean monthly savings in operating costs after switching to a heat pump by income group and NYCI scenario. Does not include upfront costs or rebates. Vertical black lines represent the median of average monthly savings. Savings only shown for homes that would save by electrifying.

Two trends stand out:

- Savings tend to be higher for medium- and high-income households, across all scenarios, because higher-income households tend to have bigger homes and use more fossil fuels in general. For instance, median monthly savings pre-NYCI are $45.43 for low-income households, $53.15 for moderate-income, $65.28 for middle-income, and $69.63 for high-income.
- The higher the allowance price, the larger the savings for all income groups, because fossil fuels get more expensive. For instance, median savings for low-income households that switch under scenario A are $69.36 compared to $55.45 under scenario C.

These savings would add up, too:

- Under scenario A, the median low-income household that upgrades in year 1 would save a total of **$9,156** over the first 11 years of the program, while the median moderate-income households would save **$11,628**.

The bottom line: homes that electrify would end up with lower energy bills today, savings that are significant, permanent, and would only grow under NYCI.

How many households would benefit?

Our analysis shows that the vast majority of households that switch to heat pumps (and weatherize, as needed) would enjoy lower bills today, and that these savings will only grow as fossil fuel prices rise under NYCI.

But how many households would actually make the switch during NYCI's first decade, if the proposed incentives were available?

By design, our proposed incentive program would offer generous enough subsidies to prompt a majority of New Yorkers to choose heat pumps when the time comes to replace their existing heating system.

This means that we can estimate the number of single and multi-family dwellings that would electrify between 2025 and 2035 by forecasting the number of fossil fuel heating appliances that are expected to fail within this period.

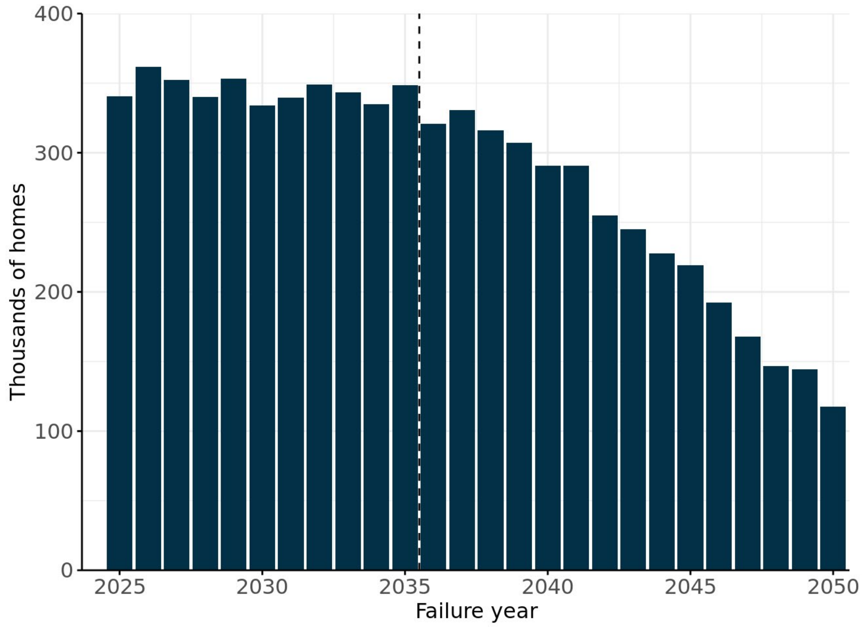


Figure 12: Number of boilers and furnaces expected to reach end of life per year from 2025 - 2050. Dashed line at 2035 denotes the end of the NYCI period considered in this analysis.

If our incentive program were implemented, up to **46%** of homes in New York State would electrify by 2035.

Altogether, these households would save an average of **$411 million** per year under scenario C. Under scenario A, households that switch would avoid paying still higher fossil fuel prices, so they'd save a total of **$524 million** per year, on average.

More households could end up electrifying, however.

Our analysis assumes that households only switch when their current heating appliance fails. In reality, higher fuel prices (and our program's attractive incentives) may spur some households to make the switch early. The higher the allowance price, the more widespread this could become—indeed, this is one of the goals of carbon pricing policies such as Cap-and-Invest.

Under these assumptions, New Yorkers would be installing between 319,000 and 328,000 heat pumps statewide each year, depending on the allowance price, and undertaking between 160,000 and 174,000 weatherization projects a year.

That’s an 11-fold increase in heat pump installations over 2022.[33]

To comply with the net-zero targets in the CLCPA, NYSERDA estimates that the state needs 2 million homes to install heat pumps by 2030.[34] By dramatically accelerating the pace of heat pump and weatherization projects, our program could electrify **1.9** million homes by that date and cut all of their energy bills.

33 According to New York’s Department of Public Service, more than 29,500 heat pump projects were installed in 2022 across New York State. (PSC 2023a).

34 See Appendix G of NYSERDA’s Integration Analysis (E3 2022).

How much would it cost?

Our proposed incentive program would effectively put the state back on track to decarbonize buildings by mid-century.

But how much would it cost to electrify and weatherize all of these homes?

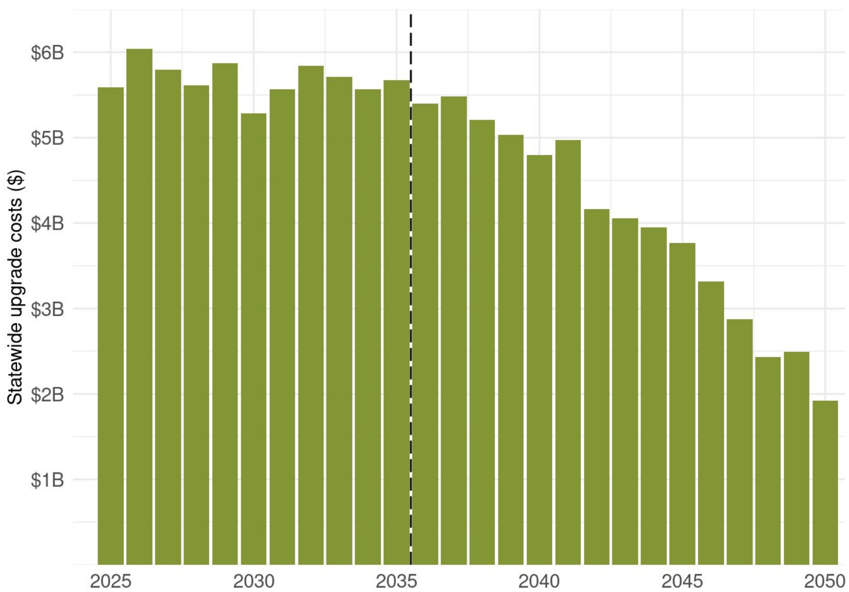


Figure 13: Total upgrade costs per year under NYCI scenario A. Dashed line at 2035 denotes the end of the NYCI period considered in this analysis.

The *total* cost of these upgrades—irrespective of who pays—would be **$62.55** billion between 2025 and 2035, or an average of **$5.69** billion a year.

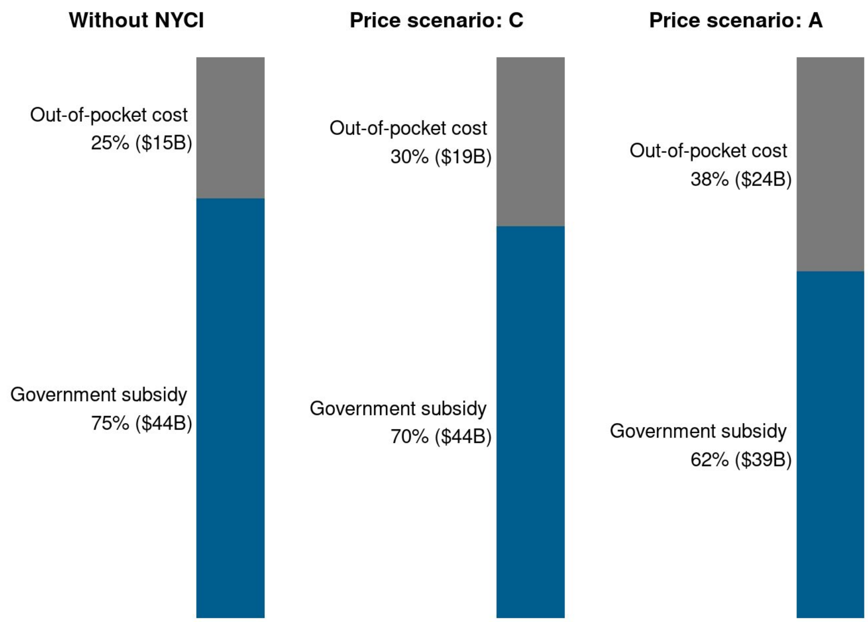
The annual cost would drop steeply thereafter, as fewer and fewer yet-to-be-electrified homes remain.

Who would pay these costs?

How much of the total cost would be paid out-of-pocket by households, and how much would be picked up by the state and federal government, including our proposed incentive program?

Because our program is based on target payback periods, the breakdown depends on the price of fossil fuels (Figure 14):

Figure 14: Total costs of transition (2025 - 2035), by payee.



As fossil fuels become more expensive under scenario C and more expensive still under scenario A, the bill savings for households switching to an electric heat pump also grows. That allows each household to achieve their target payback period with a smaller subsidy.

Consequently, the state would have to cover a smaller *share* of the total cost, even as it takes in more total revenue from NYCI.

Due to the progressive design of our incentive program, the out-of-pocket amount paid by individual households would increase based on their income level (Figure 15):

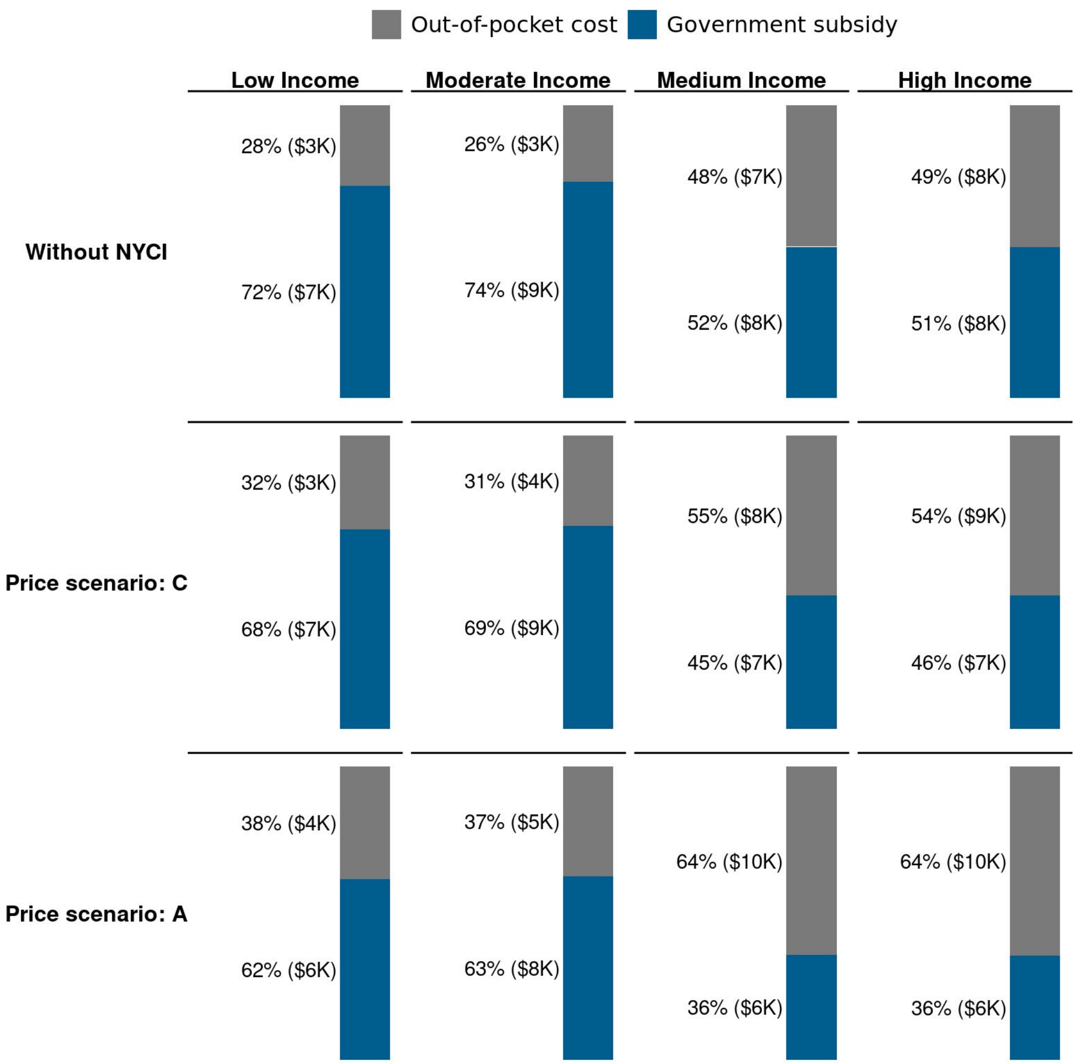


Figure 15: Average up-front upgrade costs and subsidies per household, by income level.

Where would the incentive money come from?

Would NYCI actually generate enough revenue to fund these generous state incentives for everyone who needs them by 2035?

To start, NYCI revenue wouldn't be the only source of funding for our proposed residential decarbonization program. It would be combined with existing government subsidies for heat pumps and weatherization: state energy efficiency programs and federal tax credits.

New York State already provides modest incentives for heat pumps and weatherization. These ratepayer-funded programs, administered by NYSERDA and utilities, are authorized by the Public Service Commission as part of the New Efficiency: New York (NENY) initiative, which aims to cut the state's energy usage 600 trillion BTUs by 2030.[35]

Historically, only half of this ratepayer-funded energy efficiency spending has gone to heat pumps and weatherization.[36] However, the Public Service Commission has asked NYSERDA and the utilities to shift the bulk of their spending to these measures going forward,[37] and they are largely planning to do so.[38]

While the budgets for the 2025 - 2030 period have yet to be approved, an average of **$800 million** a year is currently earmarked for the residential sector. NYCI revenue could build on this funding: instead of starting brand new, duplicative incentive programs, Cap-and-Invest revenue could simply fund the expansion of existing ratepayer-funded programs, while adding needed funding for retrofit-readiness repairs.

The federal Inflation Reduction Act (IRA), meanwhile, contains incentives for weatherization and heat pumps, including the 25C tax credit for owner-occupied units, and the 179D deduction for renter-occupied ones. Assuming every eligible project takes advantage of these subsidies, we estimate the IRA would contribute approximately $587 million a year to covering the cost of our program.[39]

Together, NENY and IRA would contribute $1.7 billion a year, on average. This is less than half of the money needed to fund our proposed household decarbonization incentive program.[40]

35 NENY was created by the New York Public Service Commission's 2018 order, Adopting Accelerated Energy Efficiency Targets (Case 18-M-0084) (PSC 2018).

36 For a historical analysis of how billions in ratepayer funds have been spent, consult Switchbox's NENY report (Sarkissian and Velez 2024).

37 See the Public Service Commissions 2023 Order Directing Energy Efficiency and Building Electrification Proposals (Case 18-M-0084) (PSC 2023b).

38 Switchbox's NENY report also evaluates NYSERDA and utility proposals for energy efficiency spending in the 2026 - 2030 period.

39 Our analysis assumes that these federal subsidies will be in place through 2035, and applies them automatically to every eligible project—even though, in reality, building owners have to claim them on their tax returns, and some may fail to do so.

40 Note that the gap would be even larger if some households opted for early retirement of their fossil fuel heating systems.

Would NYCI revenues be able to close the gap?

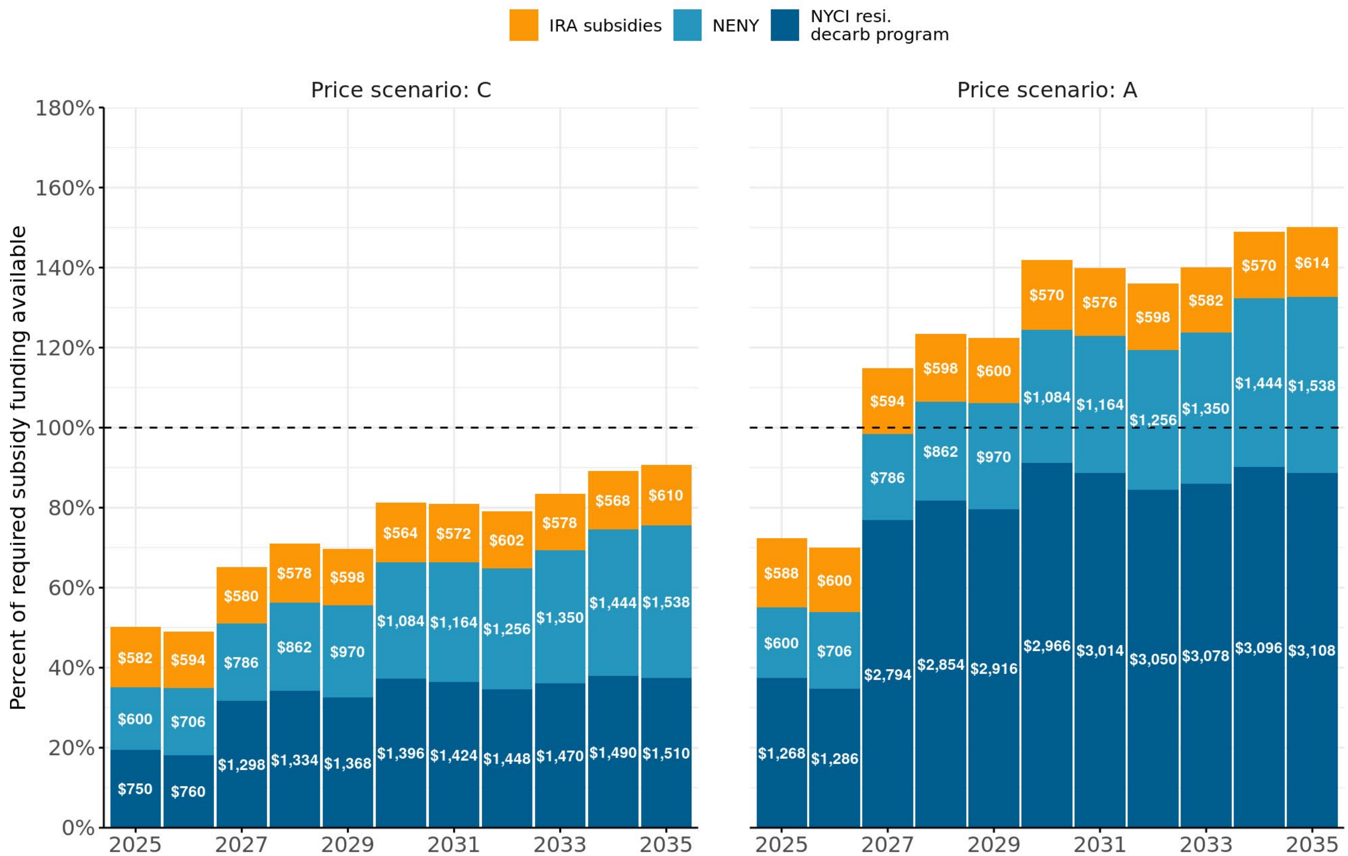


Figure 16: Percent of required program subsidy cost available by source (2025 - 2035). Dollar values are in million USD.

Recall that our spending scenario allocates 23% of NYCI revenue to household decarbonization incentives (see Section 2.4).

Under scenario A, this would amount to $2.5 billion a year, on average, between 2025 and 2035—more than enough to close the funding gap. Indeed, the program would run a surplus starting in 2027, providing funds to incentivize early retirement and giving New York a further leg up on hitting its climate goals.

Under scenario C, the program would receive $1.2 billion a year, on average. This would not be sufficient to close the funding gap. Together with NENY and IRA, NYCI would only be able to provide full incentives for **74%** of the heating system replacements that would arise over the 11 year period.

Trade-offs under a low price scenario

Should the state choose the lower price ceiling on allowances under scenario C, then, there would be trade-offs to consider.

First, the state could allocate more of the investment fund revenue (meaning money that is not already earmarked for direct rebate) towards residential decarbonization incentives. This could fully fund the program, but would only leave a total of $1.4 billion for the transportation, commercial decarbonization, and workforce training programs between 2025 and 2035.

Second, the state could make the incentives less generous, but continue to target everyone. The vast majority of New Yorkers would be eligible to get subsidies. Less generous subsidies would make it much less likely that every boiler and furnace that dies after 2030 is replaced by a heat pump, which would jeopardize the goal of decarbonizing the state's buildings by 2050. Moreover, this approach raises equity issues: with less generous incentives, those who can afford the upfront costs of heat pumps will disproportionately be higher-income households.

Third, the state could maintain generous incentives, but target them towards highly energy-burdened households, or households in disadvantaged communities that rely on delivered fuels. Doing so would ensure that incentive levels are high enough to make heat pumps an automatic choice for these households. But that would leave many other households without generous incentives, which would also put the state's climate goals at risk.

A NYCI program with price ceilings closer to scenario A would avoid these trade-offs, keeping the state on track to meet its mandated decarbonization targets while helping more households lower their energy bills.

PLACE-BASED INVESTMENTS

With new funding from the NYCI program, the state has an opportunity to direct resources to place-based, community investments that everyday New Yorkers can tangibly benefit from and attribute to the CLCPA. Further, new funding sources could directly alleviate long-standing climate burdens and environmental pollution in disadvantaged communities.

In defining its equity mandate, the Climate Act makes a clear distinction between making investments and seeing actual benefits, stating that disadvantaged communities shall receive no less than 35% "of overall *benefits* of spending on clean energy and energy efficiency programs, projects or investments in the areas of housing, workforce development, pollution reduction, low-income energy assistance, energy, transportation and economic development."[41]

41 As codified in NY Environmental Conservation Law § 75-0117 (State of New York 2020).

In other words, simply allocating NYCI revenue to such programs in disadvantaged communities is insufficient. By law, the state must also ensure that these programs actually deliver tangible benefits to the people that live there, such as improved energy affordability, health, and safety.

Current state spending on climate mitigation—whether through the Clean Energy Fund, Clean Energy Standard, or other funding mechanisms—has largely focused on incentivizing the deployment of clean energy technologies, including electric vehicles, large-scale wind and solar farms, rooftop solar, and heat pumps.

However, such programs alone will not deliver the full range of benefits disadvantaged communities need, such as access to green spaces, walkable neighborhoods, and improved indoor air quality.

Therefore, we suggest prioritizing investments according to their ability to:

1. Cut co-pollutants
2. Lower barriers to clean energy adoption
3. Deliver felt impacts

These outcomes would be integrated into a performance measurement framework that takes a nuanced approach to evaluation.

Cutting co-pollutants

In spite of significant state efforts to advance large-scale renewables, co-pollutant emissions are not improving in New York State.

Such emissions have, in some cases, worsened. A recent analysis of ozone pollution in New York State estimated the maximum daily ozone pollution attributable to the combustion of fossil fuels in the building sector would increase by 1.3 to 2.1 times between 2016 and 2023.[42]

A more direct focus on reducing co-pollutants could cut greenhouse gases while alleviating health burdens for communities living near polluting infrastructure.

Lowering barriers to clean energy adoption

The state has identified four major categories of barriers that are preventing disadvantaged communities from accessing existing clean energy and energy efficiency programs:[43]

- Physical conditions, such as aging housing stock that requires additional investment to support new technologies.
- Financial resources, such as lack of credit and financial institutions, and lack of spare time.
- Perspectives and information, such as distrust in and lack of understanding of state agencies.
- Program design and implementation, including complex eligibility requirements for incentive programs, and lack of coordination across agencies and regions within the state.

Delivering felt impacts

Felt impacts—benefits that are useful and visible to residents living within a disadvantaged community—should be central to program design. These may include:

- Health benefits, such as better indoor air quality and reduced respiratory illness.
- Affordable, comfortable homes that reduce energy burdens.
- Improved resilience to climate impacts.

42 As documentedi in a recent report from the Sieera Club on Ozone Impacts (Sonoma Technologies 2024).

43 These obstacles are defined on p. 10 of NYSERDA's DAC Barriers and Opportunities report (NYSERDA 2021).

A model from California

Established in 2016, California's Transformative Climate Communities (TCC) program uses cap-and-trade dollars, coupled with state general funds, to provide large grants to communities to advance community-informed priorities such as building affordable housing, providing training for green jobs, making pedestrian improvements, decarbonizing public transportation, and other climate-related projects.

Grants are awarded for planning ($300,000), project development (up to $5 million), and Implementation (around $30 million). Additionally, TCC programs have been successful at raising complementary funds, often doubling and tripling the amount the state contributes.

Five areas of the state have received implementation grants, including Fresno, a city with high concentrations of poverty, poor air quality, and high exposure to pesticides. As an inland city in the San Joaquin Valley, Fresno already experiences extreme heat—a problem that is expected to worsen as the climate warms.[44]

Transform Fresno launched in 2018 with a $66.5 million grant from TCC. A 164-member steering committee developed options for packages of programs, which were put to a final vote by the community.

As a result, Transform Fresno has completed a number of projects with felt impacts:

- A housing development with 56 affordable units.[45]
- 85 electric vehicle chargers that will eventually host 34 electric vehicles, available for by-the-hour rental at discounted rates for low-income drivers.[46]
- No-cost rooftop solar installed on 89 low-income single-family homes and 2 multi-family buildings.[47]
- Planting 1,273 drought-tolerant and fruit trees to increase the tree cover and provide area residents with access to nutritious food.
- Planting an additional 386,533 square feet of greenery.
- Providing job training to 379 people in solar installation, welding, weatherization, and waste management.

44 From p. 25 of the UCLA Luskin Center evaluation of Transform Fresno (Karpman et al. 2024).

45 *ibid.*, p. 11

46 *ibid.*, p. 12

47 *ibid.*, p. 12

In addition to its 17 solely TCC-funded projects, Transform Fresno raised another $117.3 million in outside grants to implement four additional projects: solar and energy efficiency upgrades, creating an improvement district in Chinatown, a fund for rooftop solar and energy efficiency upgrades, and new trails, bike lanes, EV bus service, and sidewalks.

Other grantees—Ontario Together, Watts Rising, and Green Together—have used TCC implementation grants to make very different investments, demonstrating the flexibility of the program.

The Luskin Center for Innovation at the University of California, Los Angeles serves as program evaluator for grantees, allowing the state to monitor and learn from its investments.

TCC projects may also lower barriers to adoption of clean energy technologies. For example, Ontario Together's solar workforce development program addressed participant mistrust in these types of programs.

A Greenlining Institute and University of Southern California report identified TCC as one of the state's best climate initiative-funded programs and as having created visible, useful benefits in its grantee communities. The report's authors attributed that success to the fact that the "projects are community-driven and well-coordinated."[48]

48 From p. 11 of the Greenlighting Institute's report on CA's Climate Investments (Lim and Fahnestock 2024).

Existing building blocks in New York

The Downtown Revitalization Initiative (DRI) is the closest existing New York analogue to California's TCC program. DRI is primarily housed at the Department of State and allocates approximately $100 million in community grants each year. The program has funded projects like public art installations, downtown and waterfront beautification, revamping old retail spaces, and solar panels for a net-zero housing development near downtown Geneva.

While it shares a fundamental framework of providing place-based grants to communities around the state, there are some differences to TCC:

- While TCC is explicitly climate-focused, DRI aims to revitalize downtowns in order to reinvigorate local economies.

- DRI focuses on bringing in shopping and amenities and does not explicitly focus on community health or environmental burdens, though there have been investments in green technology, public transit, and biking.[49] TCC aims to more directly improve the quality of life for existing residents of disadvantaged communities, with the idea that economic development will follow from climate-related investments.
- Both programs are administered by government agencies but rely on local community groups to steer grants. DRI's community boards are advisory, however, whereas community organizations direct the funding under TCC.
- Both programs provide free consulting and technical assistance to community groups, but TCC's support is more comprehensive and includes post-implementation evaluation.
- TCC uses a tiered grant-making approach, funding planning and project development prior to implementation.
- TCC has an explicit goal to mitigate potential adverse consequences of new development such as displacement of current residents.
- TCC implementation grants tend to be larger (around $30 million) and go to fewer communities, while DRI grants range from $10 - $20 million, but reach more individual communities. The larger grants help communities achieve more ambitious goals.

With NYCI revenue, New York could integrate these successful facets of TCC into the existing DRI program, or potentially create a new TCC-style program that subsumes DRI but is more community-driven, explicitly targets Climate Act goals and disadvantaged communities, and incorporates more robust post-implementation evaluation.

Our spending scenario would allocate $1.5 billion to place-based investments under scenario C, which would double DRI's current yearly budget, and $3 billion under scenario A, which would triple it.

Between 2025 and 2035, scenario C could provide 50 communities with $30 million implementation grants, while scenario A could double the size of the grants or the number of communities receiving them.

49 See the NY Department of State's report on the DRI Brownfield program (NYDOS 2022).

DIRECT REBATES

Caution

Our rebate design is not intended as a directly adoptable policy. It is meant to be illustrative, allowing us to demonstrate how well-designed rebates could indeed offset the added costs faced by economically vulnerable households.

Governor Hochul has pledged to design the NYCI program so as to avoid saddling disadvantaged communities with the financial cost of cutting emissions.

The state plans to mitigate consumer costs in two key ways:

- **Price Ceiling**: By using a price ceiling, which ensures that allowance prices do not exceed a certain threshold. Doing so limits the cost to companies and therefore the costs passed down to consumers.
- **Direct Rebates**: By funneling the billions of dollars in revenue generated from these auctions into rebates that directly offset consumer costs, particularly for households. By law, the state must set aside at least 30% of NYCI's revenue for this purpose.[50]

In this section, we propose a direct rebate program that fulfills the goal of insulating economically vulnerable New Yorkers from increased costs. In effect, our rebate program transforms Cap-and-Invest from a regressive to a progressive funding mechanism for funding decarbonization efforts.

50 NYS Public Authorities Law, Article 8, title 9, §1854 (State of New York 2023).

FOSSIL FUEL COSTS UNDER NYCI

In our analysis, we assume that gasoline, natural gas, and delivered fuel companies will pay for the cost of their allowances by raising the price of fuel accordingly.

As allowance prices increase under each price ceiling scenario, therefore, New Yorkers would likely see a rise in the price of gasoline, oil, propane, and natural gas.[51]

Delivered fuels
Fossil fuels like propane or heating oil, which must be delivered by trucks when homes lack natural gas hookups.

51 Although half of NYS's electricity is powered by fossil fuels (NYISO 2023), electricity prices will likely not rise. The state is leaning towards exempting power plants from NYCI because they already participate in RGGI, a multi-state cap-and-trade system exclusively for the power sector.

In addition to raising money for public investment, Cap-and-Invest accelerates decarbonization by steering private decisions towards clean energy.

To that end, consumers would likely respond to these cost increases by lowering their consumption of fossil fuels and by substituting with electric technologies (heat pumps, EVs, etc.), both of which would cut emissions.

Rebate design: minimizing burdens

While the higher fossil fuel prices under NYCI would help decarbonize New York State, they also have the potential—without mitigation strategies that are already envisioned in the design of the program—to disproportionately burden lower-income households, especially those with high energy costs, for two distinct reasons:

- **Regressivity**: A uniform increase in fossil fuel prices hits lower-income households harder, since these *new* costs eat up a larger portion of their budget. That's because they spend a larger portion of their income on fossil fuels to begin with.[52]
- **Inelastic demand**: Lower-income households are less able to curb their fossil fuel consumption, as most of it goes to meeting basic needs (heating, cooking, and so on), and they often lack the capital to install heat pumps, weatherization, and EVs, which would lower their energy bills.

For these reasons, New York State seeks to direct rebates to those households who would be most burdened by higher fossil fuel costs: Governor Hochul stated that NYCI revenues should be directed to New Yorkers from disadvantaged communities to help cover utility bills" so as to ensure "those who have already suffered from environmental injustice no longer bear an unfair share of the burden."[53]

NYSERDA, in its NYCI affordability report, said that the rebates "should be designed to deliver maximum benefits to low-income households" and recommended excluding high-income households from the rebate program.[54]

52 To see why, consider a household making $30,000 per year, another making $120,000. Both spend $3,000 a year on fossil fuels—10% and 2.5% of each household's income, respectively. If fossil fuel prices increased by 20%, both would pay an additional $600 a year. However, this *increase* represents .5% of the $120,000 household's income, but 2% of the $30,000 household's income—a four-times larger chunk of the latter's budget.

53 From Gov. Hochul's press release announcing the NYCI program (NYS 2023).

54 From p. 20 of NYSERDA's NYCI Affordability report (NYSERDA 2023).

The direct rebate program we propose fulfills the state's goal of directing rebates towards the households who would otherwise be **most burdened** under NYCI.

Specifically, our objective is to fully offset increased fossil fuel costs for **low-income** households and reduce costs for **moderate-** and **middle-income** households. We define these income levels in the following section.

Rebate design: household size and cost-of-living

What determines how **burdensome** higher fossil fuel prices are to a household?

Given two households with the same income, the one with more people, or the one located in a higher cost-of-living area, will have less **discretionary income** left over after paying for essentials. For this household, higher fossil fuel prices result in larger sacrifices, all else equal.

While households with lower income should receive higher rebates, basing the rebate purely on income misses the impact that household size and cost-of-living have on cost burden.

Basing the rebates on a household's **income level** instead does a better job of identifying similarly-burdened households.

In this report, we define **low-**, **moderate-**, **middle-**, and **high**-income levels in terms of the Area Median Income (AMI) for households of the same size:

Income level	Definition
Low	0 - 60% AMI of same-sized households
Moderate	60 - 100% AMI of same-sized households
Medium	100 - 180% AMI of same-sized households
High	180%+ AMI of same-sized households

Table 3: Income level definitions

For instance, a four-person household making $40,000 a year, living in a county where the median income for four-person households is $80,000, would have an *AMI percentage* of 50%, and would therefore be classified a *low-income*.

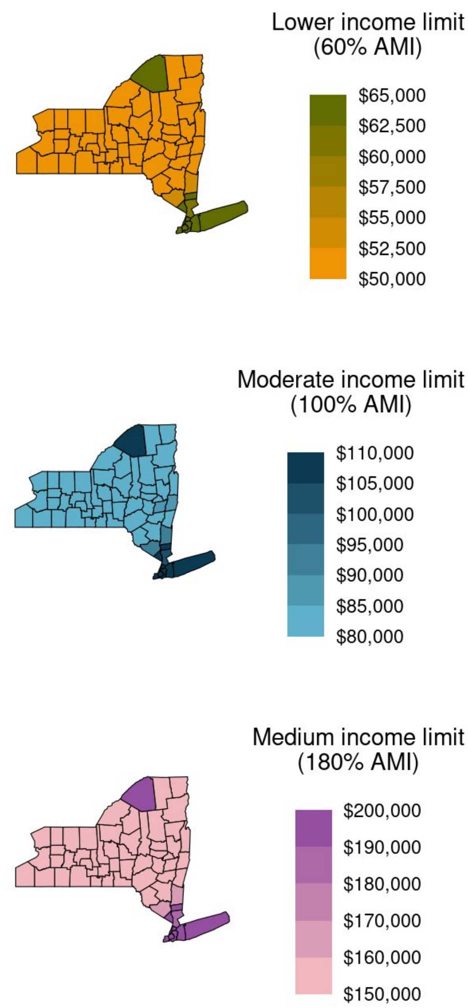


Figure 17: Upper income limit for low-, moderate-, and medium-income levels, by county, for a four-person household.

Using a household's AMI percentage instead of gross income allows us focus on what matters: **discretionary income**, or the amount left over after a household pays for necessities:

- Two households of *different* sizes, located in the same county, each making 80% of the Area Median Income, would have different yearly incomes: $77,717 for a household of three living in the Bronx, and $86,306 for a four-person household.[55] But they would have similar amounts of discretionary income.
- Likewise, two same-sized households, both making 80% of AMI but located in counties with *different* costs-of-living, would also have different incomes. But they'd have roughly the same amount of cash left over after paying for necessities, and would therefore be similarly burdened by price hikes.

That is, unless one of these households spends significantly more on fossil fuels.

55 For the dollar values of low- and moderate- income limits by county, see the appendix.

Rebate design: fossil fuel expenditures

To deliver rebates to the most-burdened households, in addition to addressing household size and cost-of-living, we must account for the fact that households at the same *AMI percentage* do not necessarily spend the same amount on fossil fuels, and would therefore not be exposed to the same cost increases under NYCI.

Households with no access to public transit may have higher gasoline costs, for instance. Older homes lacking insulation, or with less efficient HVAC systems, may require more energy to heat. The more gasoline, natural gas, or delivered fuels a household consumes, the more exposed they are to rising fossil fuel costs under NYCI.

To minimize cost burdens, economically vulnerable households that are more exposed to cost increases should receive higher rebates. However, verifying each household's yearly consumption of fossil fuels, in order to deliver an appropriate rebate, would be difficult for the state to administer and increase paperwork for households.

Thankfully, geography provides a useful shorthand for approximating a household's fossil fuel usage, which varies widely across the state.

Households in New York, Bronx, Queens, Kings, and Richmond counties, for instance, use far less gasoline, on average, than households with less access to public transit, and use virtually no propane. In Franklin and Clinton counties, many households rely on expensive heating oil for heat and hot water. Elsewhere, as in Erie and Orleans counties, natural gas is the largest source of household energy costs.

Figure 18 shows the average monthly increase in household energy costs, *before rebates are factored in*, for low- and moderate-income households by county.[56]

56 Based on a Switchbox analysis of datasets from NREL, EIA, DEC, and NYSERDA.

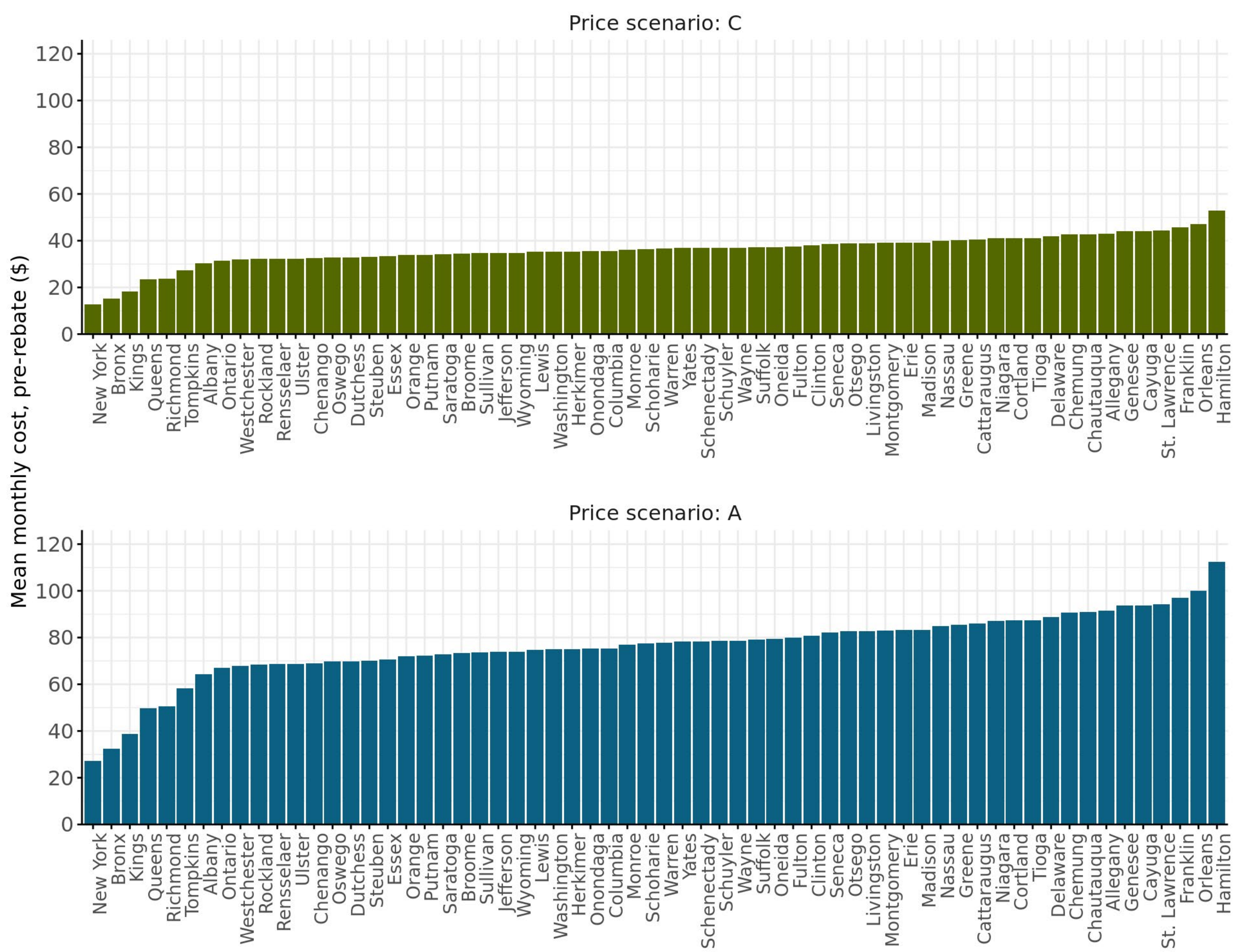


Figure 18: Pre-rebate average monthly increase in fossil fuel costs to low and moderate income households, per county, under price scenario C (top) and A (bottom). Mean monthly cost increases are averaged over the period 2025 - 2035.

These cost estimates, which are averaged between 2025 - 2035,[57] are highly conservative: they do not assume that households will curb their fossil fuel consumption or adopt clean technologies in response to higher fuel prices. **In reality, cost increases for LMI households will likely be lower**.

Overall, fossil fuel cost increases would be lower in the state's more urban counties and higher in rural areas. This difference is more stark under scenario A, which, due to a higher price ceiling on allowances, would have a greater impact on fuel costs.

A limitation of basing rebates on a household's county is that not only does fossil fuel usage vary *between* counties, it also varies *within* them: depending on their location, households would use natural gas or delivered fuels to heat their homes, but not both. In counties at the edge of the gas distribution network, averaging these costs together would result in natural gas households being overcompensated and delivered fuel households being undercompensated. Basing compensation on a household's census tract instead of county would help to alleviate this issue at the cost of more complex implementation.

Despite this limitation, our simulation results (see Section 3.3.6) show that basing rebates on a household's home county would successfully alleviate burdens for the vast majority of low and moderate income households.

Rebate design: compensation levels

Given these considerations, how would our rebate program actually set compensation levels?

We designate a *full rebate amount* for each county, designed to cover the average increase in fossil fuel costs that would be experienced by local low- and moderate-income households in a given year.

Low-income households would receive the full rebate amount. Moderate- and middle-income households would receive a fraction of the full rebate, proportional to their income level. High-income households would receive no rebate.

To illustrate our proposed compensation levels, Figure 19 shows the average monthly rebate, over the first decade of

57 Within that decade, costs would start out lower and increase over time.

NYCI, for a four-person household in Bronx, Dutchess, and Nassau counties.

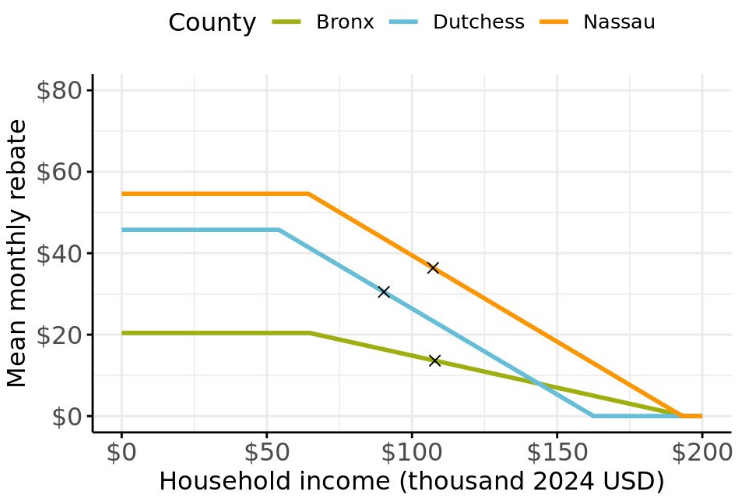


Figure 19: Monthly rebate amount received by four-person households in Bronx, Dutchess, and Nassau counties, by annual income. Rebates averaged from 2025 - 2035. X denotes each county's median income for four-person households.

Low-income households[58] would receive the full rebate amount *for that county*: those in the Bronx would receive a smaller rebate ($20 per month) than those in Nassau County ($55). Low-income households on Long Island drive more and use more delivered fuels, and would thus be more burdened by higher fossil fuel prices.

58 Those earning less than 60% of the Area Median Income for same-sized households.

The rebate would begin to ramp down for moderate-income households, and hit zero at the top of the range for medium-income households.[59]

59 180% of AMI for same-sized households.

Rebates would phase out at different income levels in different counties, due to differences in cost-of-living: in Dutchess County, four-person households making under $54,185 would receive the full rebate amount, compared to $64,357 in Nassau County, while those making above $162,554 would receive no rebate, compared to $193,071 in Nassau County.

Figure 19 illustrates how **income**, **fuel expenditures**, and **cost-of-living** affect compensation levels. What about **household size**?

[Figure 20](#) shows the compensation levels by income for Dutchess County households with one, three, and six people.

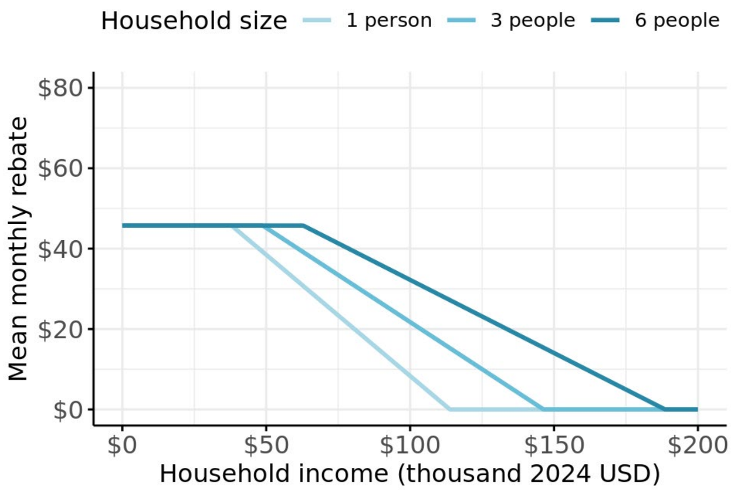


Figure 20: Monthly rebate amount received by one, three, and six-person households in Dutchess County, by annual income. Rebates averaged from 2025 - 2035.

While the full rebate amount would not increase for larger households, the rebate phase out would begin and end at higher incomes.

Finally, because we set the full rebate amount to cover the average increase in fossil fuel costs in each county, as the **allowance price** increases, so would the compensation levels (Figure 21).[60]

60 This trend of higher rebates at higher price ceilings would hold regardless of rebate design (e.g. even with a equal rebate to all households), since total rebate spending would be a percentage of total program revenue.

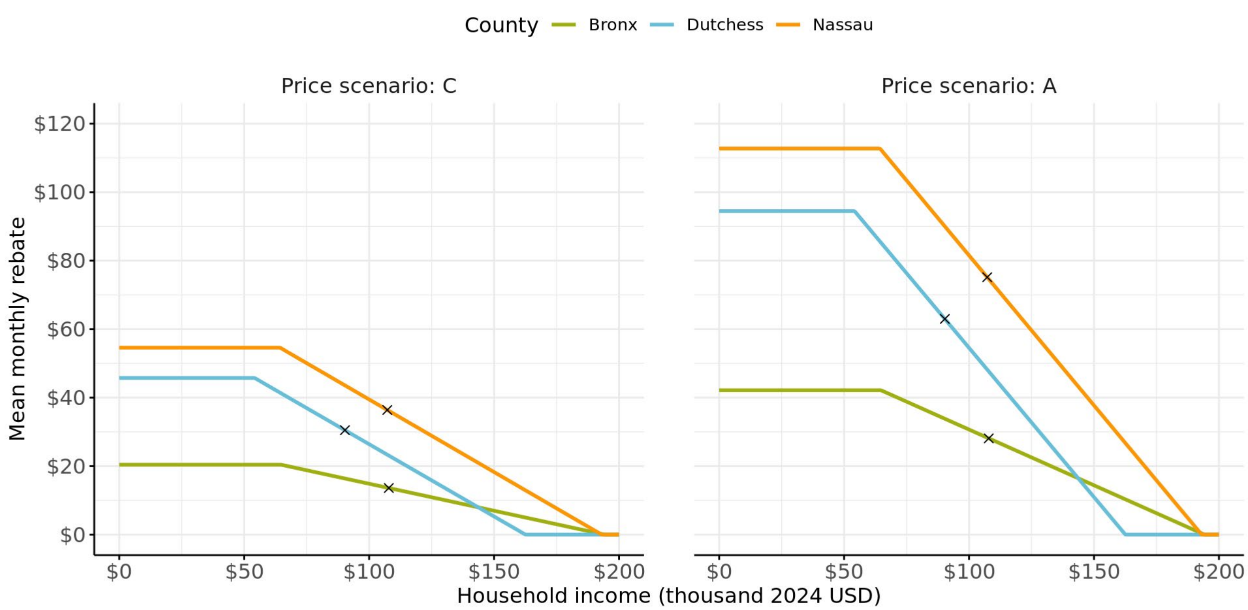


Figure 21: Monthly rebate amount received by four-person households in Bronx, Dutchess, and Nassau counties, by annual income. Rebates averaged from 2025 - 2035. X denotes each county's median income for four-person households.

Economically vulnerable households facing higher fossil fuel prices would need larger rebates to offset these costs, but more revenue would be available to fund these rebates.

In other words, all eligible households would receive more generous rebates under scenario A (right) than C (left).

Note

While these charts show the average rebate over 11 years, rebate amounts will vary over time, increasing proportionally to the program revenue.

Impact of the rebate program

Would allocating 40% of NYCI revenues to our rebate program be enough to alleviate the burden of rising fossil fuel costs for economically vulnerable households?

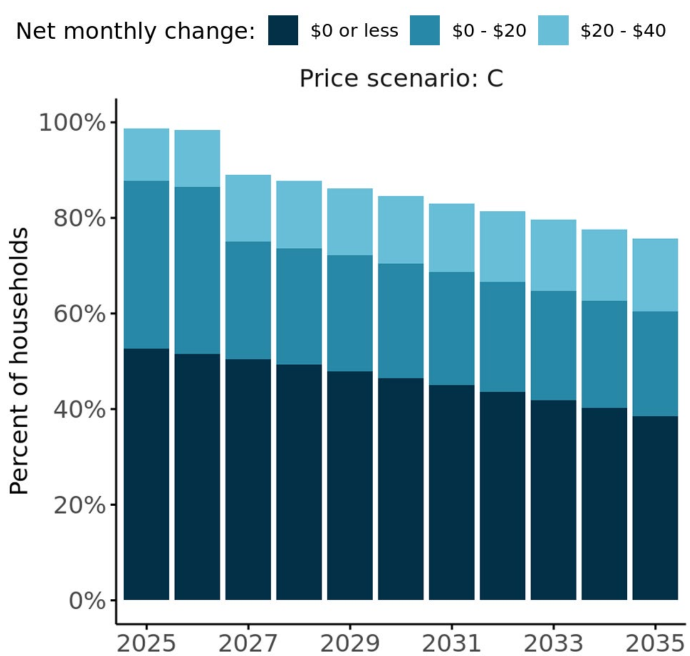


Figure 22: Post-rebate change in energy costs for New York householders, under NYCI scenario C

In all, our proposal would provide direct rebates to **83%** of New York households, while fully insulating **46%** from higher fossil fuel costs under NYCI—assuming that *no* households have reduced their fossil fuel consumption or switched to heat pumps and EVs.

A further **26%** of households would see energy costs rise by $0 - $20 a month, and **14%** would pay an extra $20 - 40. In all, **86%** of New York households would pay below $40 a month extra under NYCI, and half of these households would have their costs fully offset.

Warning

In reality, due to accelerated heat pump and EV adoption over the next decade, combined with the residential building decarb incentives in Section 3.1, a **larger percentage** of New York households would be fully insulated from higher fossil fuel costs, and would in fact enjoy lower bills than today.

Figure 23 shows the change in monthly energy costs that New York households would experience under scenario C after receiving their rebates.

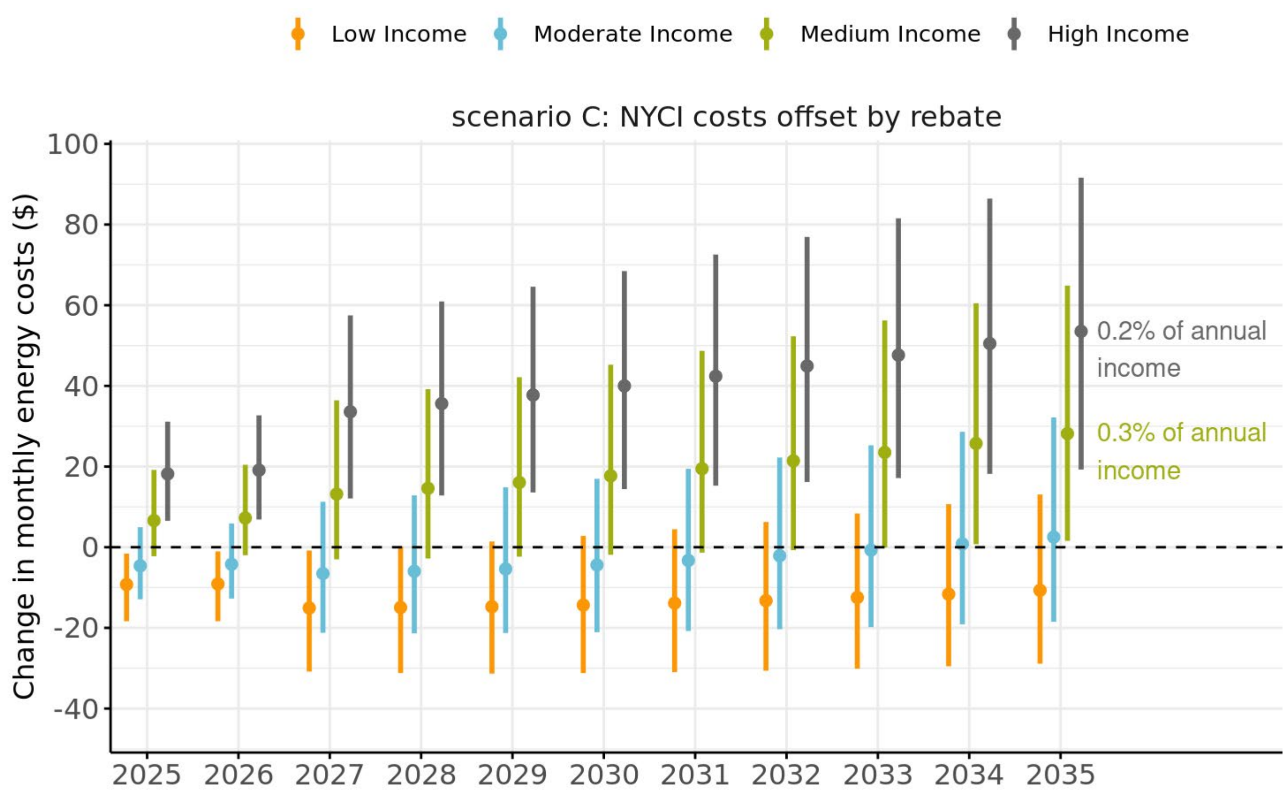


Figure 23: Change in monthly household energy costs under NYCI scenario C, assuming households don't consume fewer fossil fuels or adopt heat pumps, weatherization, or EVs. (Negative numbers represent lower energy spending than today. Range reflects the middle two-thirds of all households in income level.) Percent annotation shows the median share of income the annual total costs represent as a percentage of annual income for middle- and high-income households.

Within each income level, households would experience different post-rebate changes in energy costs, due to differences in fossil fuel consumption. The dots represent the median post-rebate cost change, while the line displays the *range* of cost changes for the middle two-thirds of the population in each income level.

Under scenario C, we find that:

- Approximately **79%** of low-income households would be fully protected from increased fossil fuel costs during the first 11 years of the program. The median low-income household would experience a small monthly net gain, due to rebates, of $11.58.
- **58%** of moderate-income households would be made whole. The median moderate-income household would experience a tiny net gain of $0.46, essentially breaking even.
- **20%** of medium-income households would be made whole. The median medium-income household would experience a monthly cost increase of $21.34 under scenario C after receiving a rebate. **This is equivalent to 0.3% of their annual income, on average.**
- The 17% of households who are high-income—with annual incomes above $200,000 in New York City and $150,000 in upstate New York—would **receive no rebate**. The median high-income household would experience a $40.69 monthly cost increase. **This is equivalent to 0.2% of their annual income, on average.**

Under scenario A, with higher allowance prices, fossil fuel costs would be higher. But because rebates would also be higher, virtually the same number of households would have their increased costs fully offset as under scenario C (Figure 24).

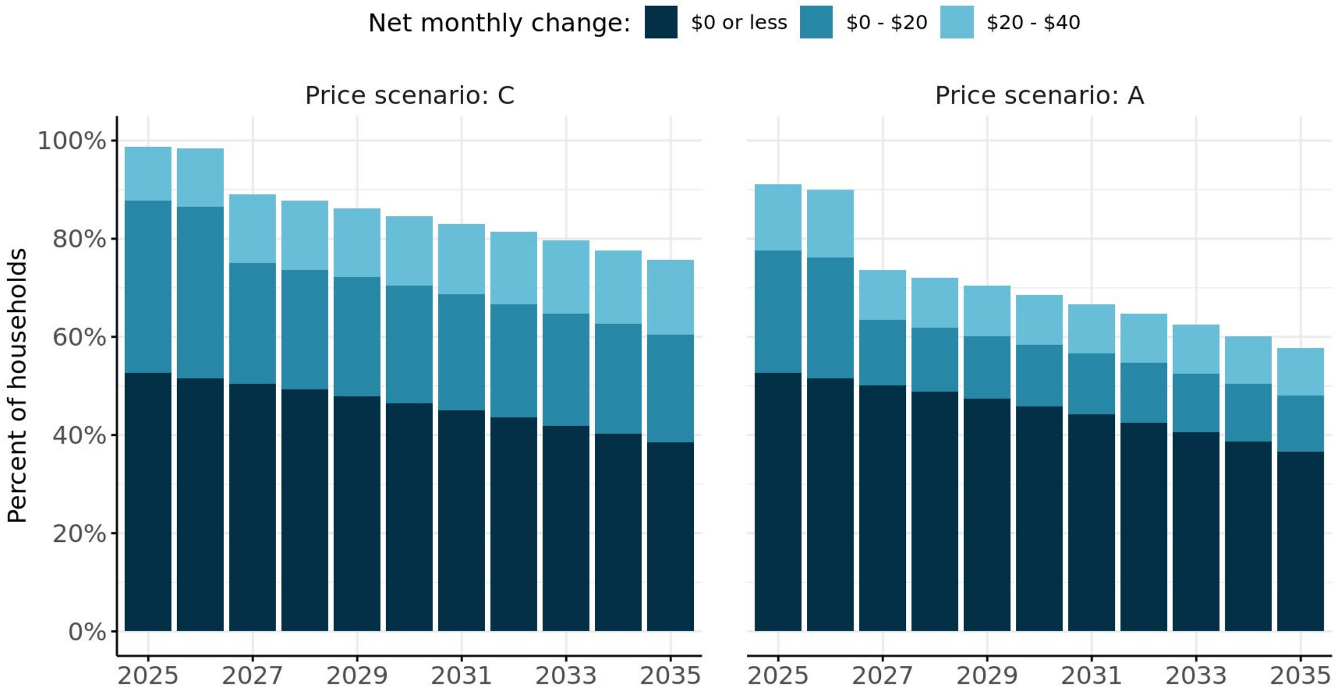


Figure 24: Post-rebate change in energy costs for New York householders, under NYCI scenario C and A.

Under scenario A, **45%** of households would be completely insulated, **15%** of households would see energy costs rise by $0 - $20 a month, and **11%** would pay an extra $20 - $40. In all, **71%** of New York households would pay below $40 a month extra under NYCI, and two-thirds of these households would have their costs fully offset.

In other words: even under higher allowance prices, which would generate significantly more revenue for decarbonization, rebates could eliminate increased energy costs for the large majority of low-income households, and effectively control them for moderate- and medium-income households.

Appendix

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DATA: HOUSEHOLD ENERGY CONSUMPTION DATASET

Our study rests on two distinct models: one for direct rebates (Section 3.3), and one for household decarbonization incentives (Section 3.1).

Before walking through the details of each model, we describe the household-level energy use dataset that underlies both, and how we estimated increased fossil fuel prices under NYCI.

Both models rely on state-of-the-art energy simulations on a representative sample of New York's buildings, detailing the consumption of electricity, natural gas, propane, heating oil, and gasoline for a representative sample of New York's households.

This dataset, in turn, was assembled from two sources:

1. Home energy consumption: NREL's End-Use Load

Profiles for the U.S. Building Stock (EULP, NREL 2021) dataset.

2. Gasoline consumption: An in-house statistical model trained on the American Community Survey's Public Use Microdata Sample (PUMS) dataset (Census Bureau 2022) and the Federal Highway Administration's National Household Travel Survey (NHTS) dataset (FHA 2022), for vehicle ownership and gasoline consumption.

We describe each in turn.

EULP: residential building characteristics and energy consumption

To estimate home energy use under different heating scenarios, we relied on ResStock, an NREL optimization model that simulates energy consumption for a representative, synthetic sample of US households. Households are simulated at a rate of 1 in 242 compared to the actual population. Simulations are run for various electrification scenarios (see Section 4.5.3).

The dataset resulting from these ResStock simulations is called End-Use Load Profiles for the U.S. Building Stock. We used the 2022 release of EULP, version 1.1 run on weather year 2018.

There are 33,676 New York housing units in EULP. The units could be stand-alone single family homes, or apartments in multi-family buildings. The dataset contains hundreds of variables describing the physical characteristics of each unit: the number of floors, number of exterior walls, wall materials, type of HVAC system, efficiency of hot water systems, air infiltration levels, solar exposure, basement types, and so on.

To illustrate, here are 10 synthetic housing units for New York, showing just a handful of the hundreds of variables available in the dataset:

bldg_id	type	square_feet	age	heating_fuel	air_conditioning
10	Single-Family Detached	885	<1940	Natural Gas	Room AC
11	Multifamily with 5+ units, 1-3 stories	1138	<1940	Natural Gas	Room AC
27	Multifamily with 5+ units, 1-3 stories	1623	1950s	None	Room AC
64	Multifamily with 2-4 Units	853	<1940	Natural Gas	Room AC
67	Single-Family Detached	2663	1970s	Propane	Room AC
69	Multifamily with 5+ units, 1-3 stories	617	<1940	Electricity	Room AC
72	Single-Family Detached	2176	1960s	Fuel Oil	Central AC
76	Multifamily with 2-4 Units	853	1980s	Natural Gas	None
132	Multifamily with 5+ units, 1-3 stories	2590	2010s	Natural Gas	Room AC
161	Single-Family Detached	1690	1970s	Fuel Oil	Room AC

ResStock uses these variables to build a 3D model of each housing unit. It then uses EnergyPlus to simulate how the units' appliances would behave in response to a sample year of weather in that geographical area.

For each unit, this simulation outputs time series of electrical, gas, and fuel oil consumption at 15 minute intervals, the so-called **load profiles**:

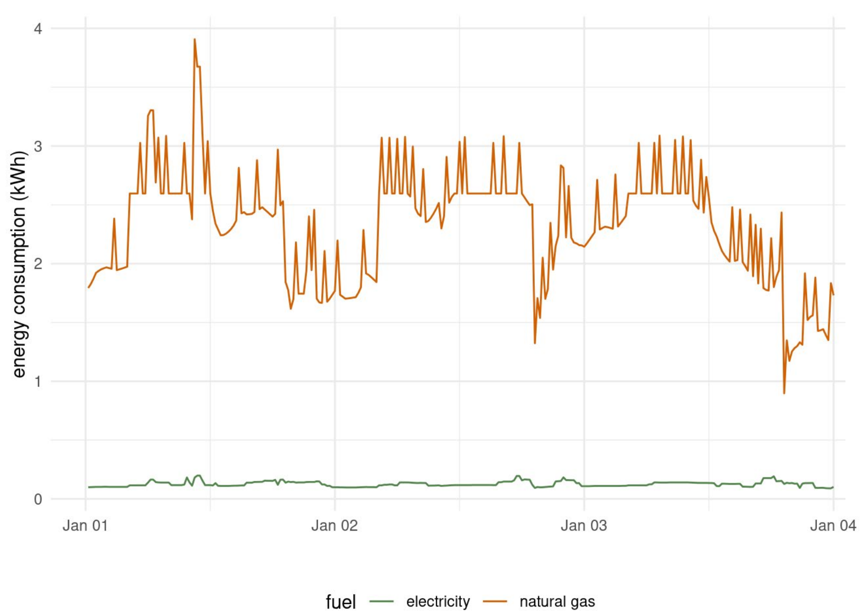

Figure 25: Electrical and gas consumption for a single unit over a three-day period in the EULP dataset.

For our analysis, we added up the amount of fuel consumed by each unit every month:

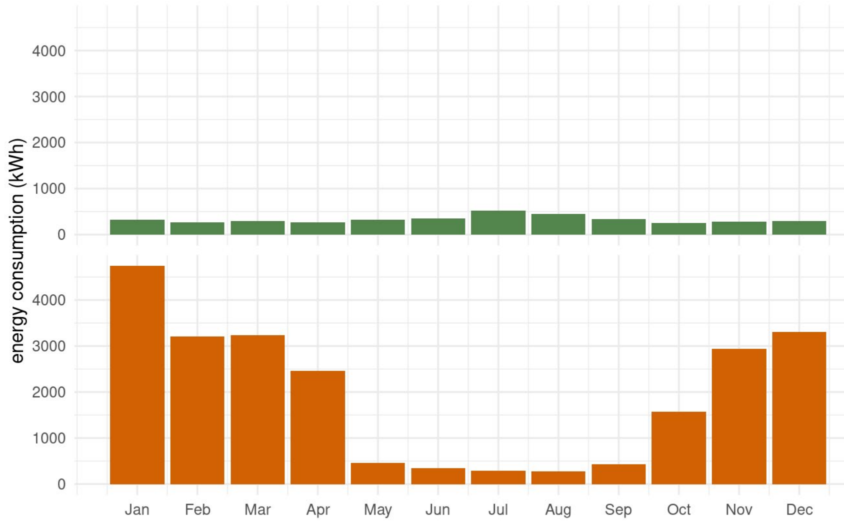

Figure 26: Monthly electrical and gas consumption for the same unit.

This particular housing unit's electricity use is steady throughout the year, while natural gas peaks in winter and plummets in summer, as expected.

In-house model of household gasoline consumption

First, we modeled household car ownership with a multinomial logistic regression model. The model was trained using Public Use Microdata Sample (PUMS) data to predict household vehicle counts (none, 1 car, 2+ cars) based on household size income, metro area/rural classification, and a New York City classification (true/false).

Predictions for car ownership were then applied to households in the EULP dataset described in the previous section.

A formal description of our logistic regression model:

$$\log \frac{P(Y=k)}{P(Y=K)} = \beta_{0k} + \beta_{1k}HH + \beta_{2k}INC + \beta_{3k}METRO + \beta_{4k}NYC$$

Where:

1. Y represents the categorical response variable (household vehicle counts: (none, 1 car, 2+ cars))
2. k is one of the categories of household vehicle counts
3. $P(Y{=}k)$ is the probability of Y being in category k

4. *HH* is household size (1-8)
5. *INC* is household income
6. *METRO* is metro area classification (In metro area, not/partially in principal city; In metro area, principal city; Not/partially in metro area)
7. *NYC* is a household in New York City flag (true, false)

Next, we generated each household's vehicle miles traveled (VMT), using VMT data from the National Household Travel Survey (NHTS).

This dataset is grouped into eight categories based on household vehicle count (1 car, 2+ cars), household size (1 person, 2+ people) and an urban/rural classification. The NHTS supplies VMT data aggregated at regional levels, and we needed to estimate household level mileage. Truncated normal distributions were created for each group using weighted mean and standard deviation values. These distributions were used to simulate household annual miles traveled.

Here's how the entire workflow worked.

To begin, ResStock households were assigned:

1. Vehicle ownership probabilities using the multinomial car ownership model.
2. Annual VMT values sampled from the relevant truncated normal distribution based on their group.

From there, we estimated household gasoline consumption. We assumed the average U.S. light duty vehicle fuel efficiency (22.8 mpg) and multiplied by each household's predicted annual VMT to estimate household annual gasoline use.[61]

61 Fuel efficiency data was collected from the Bureau of Transportation Statistics (BTS 2019).

METHODS: FORECASTING HOUSEHOLD ENERGY COSTS UNDER NYCI

With this household energy consumption dataset in hand, we needed to calculate how much each household's annual energy costs would increase under a given allowance price. The household cost increases directly inform the direct rebate model, and indirectly affect the residential decarb incentives model.

First, we calculated the percentage cost increase for a unit of each type of fossil fuel, given a particular allowance price. This required calculating each fuel's emissions intensity, using New York's emissions accounting rules.

For each fuel type, we applied conversion rates to estimate the upstream and downstream CO_2-equivalent emissions per unit of fuel.

fuel	units	CO_2e per unit		
		upstream[1]	combustion[2,3]	total
oil	gallons	3.0	11.6	14.6
natural gas	Mcf	44.0	55.0	99.0
propane	gallons	2.5	5.8	8.3
gasoline	gallons	0.7	9.2	9.9

Table 4: CO_2e per unit of fuel.

1 upstream emissions factors
2 combustion emissions factors
3 combustion emissions factors

These emissions estimates were then used to calculate the additional cost per fuel unit at various NYCI allowance prices. This approach enabled a consistent evaluation of the carbon-related costs across different fuel types.

These per-allowance-price, per-fuel cost increases were applied to each household's consumption of that fuel, for every year in price ceiling scenarios C and A.

METHODS: DIRECT REBATE MODEL

Households were assigned income groupings based on the greater of the Area Median Income (AMI) or State Median Income (for their household size). Income in the ResStock dataset was provided in 2019 USD, which we adjusted to 2024 USD using the Employment Cost Index for the Middle Atlantic Census Division. Income brackets for 2024 were defined using 2021 AMI data from the U.S. Department of Housing and Urban Development (HUD), scaled by the same inflation index. Dollar values are provided in Section 4.5.8.

The rebate pool was set by statute to be no less than 30% of overall revenue.[62] We allocated 40% of total revenue to rebates,

62 NYS Public Authorities Law, Article 8, title 9, §1854 (State of New York 2023).

with the understanding that the additional 10% may take the form of bill credits. We used NYSERDA's revenue estimates under price scenarios A and C.[63] To account for geographic variability in energy consumption, we summed the estimated costs for each household over the 11 years, averaged them by county, and normalized these values to create a scaling multiplier from 0 to 1, where counties with higher average costs had values closer to 1. These cost averages excluded the cost of high income households.

63 See NYSERDA NYCI Pre-Proposal (NYSERDA 2023).

Rebate eligibility was based on income. Low-income households (≤60% of median income) received a rebate based on county. Moderate- and medium-income households received a county-based rebate, scaled down by income up to the 180% of AMI. High-income households, with income above 180% of AMI, were ineligible for rebates. See Section 4.5.8 for dollar values.

METHODS: HOME DECARBONIZATION INCENTIVES MODEL

Our home decarb incentives model is complicated, and rests upon a number of important concepts. We review those first.

Concepts

Upgrades

Some households would cut their energy bills just from switching to cold-climate air source heat pumps (ccASHPs).

Others might only save money if their home is also weatherized, or would save enough from weatherization to justify the cost.

In addition, some households would require repairs to make weatherization possible (such as remediating mold or asbestos). Our incentive program would subsidize these repairs for low- and moderate-income households when weatherization is indicated.

Up-front costs

The up-front costs of whatever **upgrades** each home needs to electrify with savings, over and above the cost of replacing the home's current heating system, would be paid by four sources:

1. **Federal tax credits** from the Inflation Reduction Act
2. **State subsidies** from New Efficiency: New York
3. **NYCI revenues**, which depend on the allowance price in a given year
4. Household **out-of-pocket expenses**, paid back by energy bill savings

Payback periods

Not every household has an **upgrade** package that can lower their bills after installing heat pumps. But for households that can achieve savings, their **out-of-pocket expenses** can be evaluated in terms of a **payback period**: how long it'll take for the resulting savings to pay back the household's share of the up-front costs.

For instance, a ccASHP purchased with no **federal tax credits** or **state subsidies** might have a 10 - 15 year payback period. Using those federal and state incentives would bring down the payback period, so residents can pocket the savings sooner.[64]

64 Over time, changes in the price of electricity and fossil fuels could change the household's ultimate payback period.

Subsidies

Our incentive program would subsidize each home's upgrades up to whatever level is required to reach the **target payback period** associated with their household's income:

Income level	Definition	Payback period
Low	0 - 60% AMI of same-sized households	3 years
Moderate	60 - 100% AMI of same-sized households	3 years
Medium	100 - 180% AMI of same-sized households	6 years
High	180%+ AMI of same-sized households	6 years

Table 5: Target payback periods used for calculating incentive levels, by income level

For example, let's say a household needing heat pumps, weatherization, and repairs has an annual income under 100% of their area's median income. We calculate the cost of these **upgrades** of a new boiler or furnace. We then calculate how much of the cost would be paid for by federal tax credits, if any. State subsidies, a combination of existing energy efficiency funds and new NYCI revenues, would apply to the remaining cost. Specifically, they would pay for whatever chunk of the remaining cost would leave the households with a three-year payback period on their out-of-pocket expenses.

Example

Let's say a high-income household installs a $17,000 heat pump, instead of buying another $5,000 boiler. Federal tax credits cover $3,000, leaving them with $14,000 to pay out-of-pocket.

They would've paid $5,000 for a new boiler, so the heat pump premium—the cost difference between the heat pump and replacing their existing system—is $9,000, in this case.

Our incentive program only subsidizes the premium, not the heat pump's entire cost. The heat pump would cut their energy bills by $1,000 a year compared with the boiler, leaving them with a 9-year payback period *on the premium*. This exceeds the household's **target payback period** of six years.

Under our residential decarb incentive program, the state would then kick in a $3,000 subsidy, leaving the household to pay $6,000 out-of-pocket for the premium, to be paid back by savings over six years.

Big Picture

For an overview of how the various components of our residential decarbonization incentive model fit together at a high level, see Figure 27. For a technical description of the model, see Section 4.5.3.1, Section 4.5.5.3, and Section 4.5.7.1.

Buildings2 dependencies

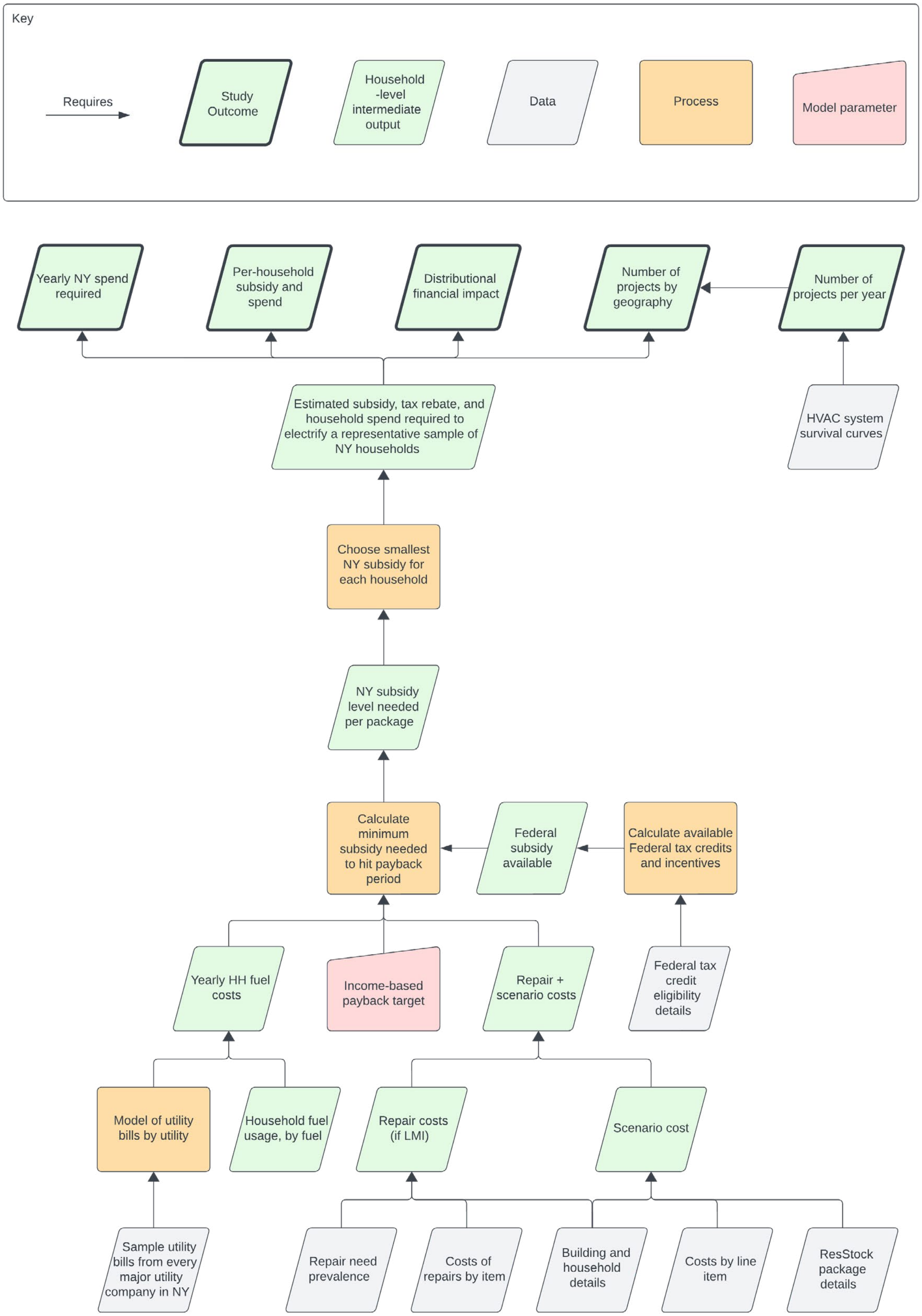

Figure 27: Dependency flowchart

This model was run multiple times for different fuel prices, corresponding to cost increases under NYCI price ceiling scenarios C and A.

Upgrade scenarios

The idea of ResStock is to simulate load profiles like these under alternative scenarios: what if the housing unit used heat pumps instead of whatever heating system it has now? What if it also applied a basic weatherization package? How would electrical and gas consumption change month-by-month as a result?

The 2022 EULP release includes 10 scenarios, each capturing a different combination of building upgrades. Our analysis uses three of these:

1. **Baseline**: simulate the building using whatever building systems are currently installed—furnaces or boilers, gas water heaters, and so on. [65]
2. **Heat pumps**: simulate the building if it used a moderate-efficiency ccASHP, heat pump water heater, and heat pump dryer (if replacing gas) instead.[66]
3. **Heat pumps + weatherization**: the previous scenario, plus a weatherization package including air sealing, insulation of roofs, basements, and wooden walls, and a handful of smaller measures.[67]

Note on heat pump efficiency

Because the 2022 EULP release only includes load profile for low efficiency[68] and very high efficiency[69] heat pumps, we felt it necessary to construct a load profile dataset using a moderate-efficiency unit, to make our results more accurate.

To simulate a moderate efficiency heat pump, we averaged the energy savings from high and low heat pumps. [70]

65 Definition of baseline scenario is here.

66 Homes with ducts receive ducted heat pumps, while homes without receive mini-splits. Full heat pump specs here.

67 Weatherization measures depend on details of each unit: for instance, only homes with wood stud walls, ducts, and basements received wall, duct, and basement insulation, respectively. For measure eligibility, see Section 4.5.4.4; for technical measure specs, see here.

68 Ducted: SEER 15 / 9 HSPF
Ductless: SEER 15 / 9 HSPF
Complete technical specs here

69 Ducted: SEER 24 / 13 HSPF
Ductless: SEER 29.3 / 14 HSPF
Complete technical specs here

70 An approach suggested and validated by Mohammad Fathollahzadeh, building simulation expert at Rewiring America.

Here's the monthly energy consumption for the same housing unit we saw earlier under scenario 2, when the gas furnace and water heater have been replaced by heat pumps:

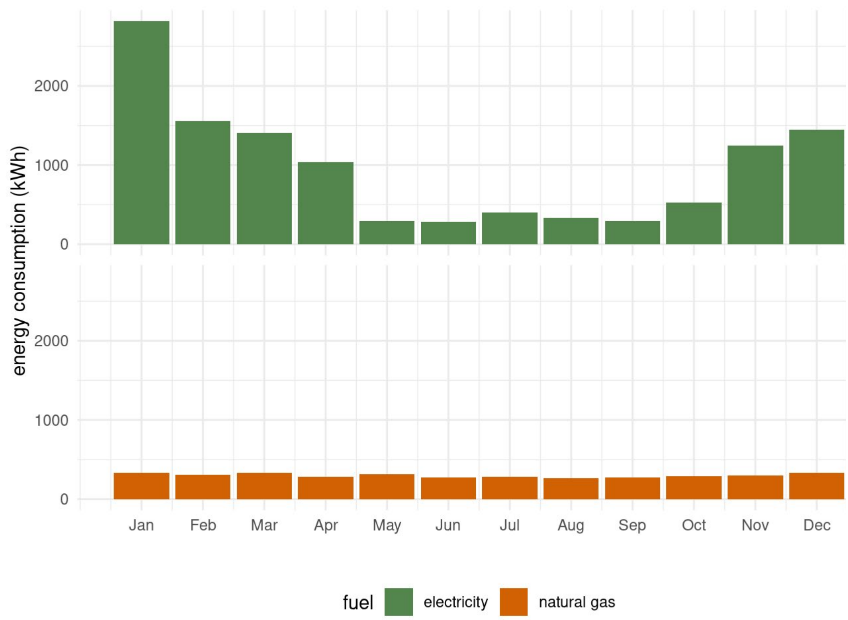

Figure 28: Electrical and gas consumption for over a three-day period, scenario 2.

Natural gas consumption is nearly eliminated, leaving only what the gas stove uses. Electricity use now has the same winter-peaking shape that gas had in the baseline scenario. Notice that the building is now consuming half as much energy, a testament to the efficiency of heat pumps.

Here's what this same unit looks like under scenario 3, after weatherization (and the stove being electrified):

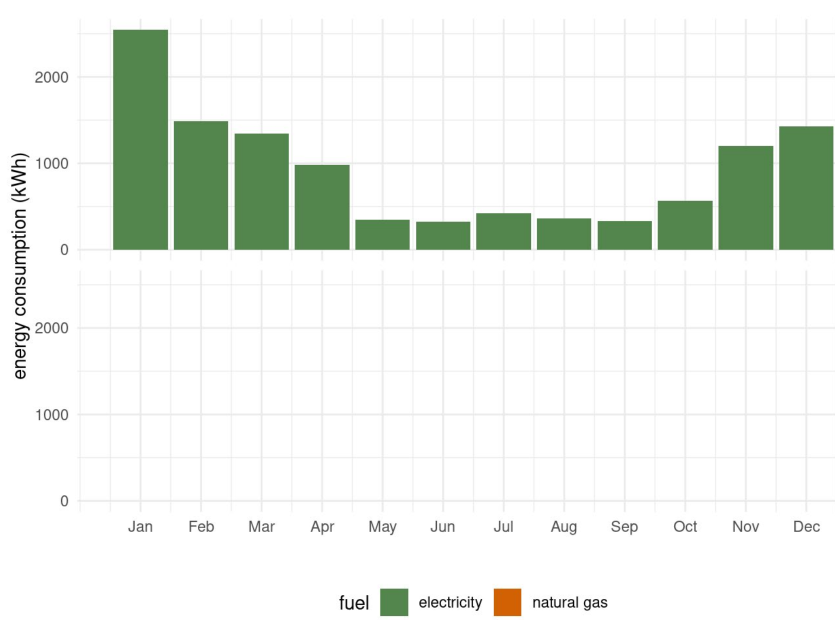

Figure 29: Monthly electrical and gas consumption for the same unit, scenario 2.

We now turn to a mathematical formalization of our model's upgrade scenarios.

Variable	Meaning
i	Index of simulated household
j	Upgrade scenario, $j \in \{0, 1, 2\}$ where j = 0 (baseline) j = 1 (heat pumps) j = 2 (heat pumps + weatherization)
$\vec{b_i}$	Vector of physical household characteristics For example: current heating system, square footage, presence of basement, insulation, and so on
k	Individual line items on an invoice For example: heat pump, furnace, insuwlation, heat pump installation labor, taxes, asbestos removal labor
$K_j(\vec{b})$	Mapping from b to the set of required k, under scenario j For example: given a particular brick apartment, what are all of the invoice line items required under scenario j = 2 (heat pumps and weatherization)?
$K_{i,j}$	The set of k for household i under scenario j Output from $K_j(\vec{b_i})$
$R(k \mid j, \vec{b_i})$	Probability of needing repair k for a | household in order to be eligible for | scenario j, based on characteristics | in $\vec{b_i}$ | | For example: needing mold remediation, removal of asbestos, etc., based on the | home vintage and region |
$R_{i,j}$	The realized set of repairs required for household i under scenario j, drawn from $R(k \mid j, \vec{b_i})$

Up-front costs

The EULP data tells us exactly which upgrades each household got under each scenario: the heat pump's BTU capacity, heat pump water heater's gallon capacity, whether they got a heat pump dryer, whether the roof was insulated with spray foam or cellulose, whether the basement was insulated, and so on.

But it doesn't tell us how much those upgrades actually cost to install. To calculate the up-font cost of each unit's upgrades, we gathered real-world prices for both equipment and labor from a multitude of sources.

Heating Systems: Heat Pumps

The cost of heat pumps varies based on capacity and model type. Using heat pump retrofit data from Massachusetts' MassSave Whole Home Electrification Pilot[71], we modeled total installation costs as a function of BTU capacity using linear regression, for both ducted and ductless systems.[72]

For a given household in scenarios 2 and 3, we used this model to predict the installation cost of the heat pump, based on its BTU capacity and whether it was ducted or ductless.

Heating Systems: Furnaces, boilers, electric Resistance

Calculating the heat pump premium required estimating the costs of re-installing existing heating systems, be they furnaces, boilers, or electric resistance heat.

- **Labor costs**: we assumed a flat $1,000 for all heating systems installations, based on conversation with HVAC contractors.
- **Equipment costs**: the housing units in the baseline had a very wide range of heating systems, so our equipment cost estimates needed to take this into account. Using web searches, we collected prices for a few dozen models of furnaces and boilers (both oil and gas), as well as electric furnaces and baseboards. We modeled equipment costs as a function of system efficiency and capacity using linear regression. For a given household in scenarios 2 and 3, we used this model to predict the equipment cost of replacing the existing heating system, based on its efficiency and capacity.

71 Massachusetts Clean Energy Center ran a Whole-Home Heat Pump Pilot from May 2019 through June 2021, and produced a detailed dataset of 158 projects.

72 Specifically, we inflated equipment and labor costs using Q4 2022 inflation indices from FRED, the St. Louis Federal Reserve's economic portal, modeled and predicted each quantity separately, and combined the predictions to arrive at the estimated heat pump install cost for a given household.

Water Heaters: Heat pumps, gas, oil, electric Resistance

Water heaters in the baseline scenario varied by fuel type (gas, oil, electricity), gallons, and BTUs. The heat pump water heaters in scenario 2 and 3 also varied by gallons and BTUs. To estimate the total up-front costs for water heaters, we used the same procedure as for (non heat pump) heating systems: a flat $1,000 for labor costs, and regression models of market prices to predict equipment costs based on fuel type, gallons, and BTUs.

Weatherization

We gathered parts and labor costs for each measure in scenario 3's weatherization package through interviews with numerous weatherization contractors:

measure	unit	cost per unit	measure applies when…
air sealing	unit footprint area (ft^2)	$3.00	ACH50 > 15
attic insulation (blow-in)	attic floor area (ft^2)	$2.50	attic is unfinished
attic insulation (spray foam)	attic floor area (ft^2)	$11.87	attic is finished, roof insulation is R-13 or less
wall insulation (drill-and-fill)	exterior wall area (ft^2)	$5.00	uninsulated wood stud walls
rim joist insulation (spray foam)	rim joist area (ft^2)	$4.75	foundation is heated basement or crawlspace
basement wall insulation (spray foam)	basement wall area (ft^2)	$4.75	foundation is unheated basement
crawlspace floor sealing (6mil plastic)	crawlspace floor area (ft^2)	$1.50	foundation is vented crawlspace
duct sealing	duct length (linear ft)	$7.00	leaky ducts in unconditioned space
duct insulation	duct length (linear ft)	$12.00	uninsulated ducts in unconditioned space

Repairs

Unlike heating systems and weatherization, the EULP dataset did *not* contain any data about the prevalence of problems like mold and asbestos that must be remediated before weatherization. Because our incentive program includes subsidies for pre-weatherization repairs, it was critical for our analysis to estimate pre-weatherization repair prevalence and costs.

To collect this data, we interviewed over a dozen weatherization contractors, asking them to estimate how often they encounter each of the following problems when they inspect low-to-moderate (LMI) income homes, and how much these problems cost to repair. We then averaged their responses to arrive at the following prevalence and cost estimates.

We found that single-family LMI buildings, which are often old and made of wood, experience a wide array of problems:

problem	prevalence	unit	cost per unit
mold in attic	12%	attic floor area (ft^2)	$4
mold in basement	7%	basement floor area (ft^2)	$4
water in basement	8%	per remediation	$1,000
vermiculite in attic	5%	per remediation	$10,000
knob & tube electrical	4%	total home area (ft^2)	$13
roof leak	7%	per remediation	$1,000

According to the contractors we interviewed, multi-family LMI buildings, especially those downstate, experience a smaller set of physical problems that directly impede air sealing and insulation, and these buildings tend to have easier access to loans to pay for remediation.

problem	prevalence	unit	cost per unit
mold in basement	7%	basement floor area (ft^2)	$4

problem	prevalence	unit	cost per unit
roof leak	9%	per remediation	$1,000

Electrical upgrades

Due to the higher electrical loads resulting from heat pumps, some older buildings, particularly multi-family ones, may require new service lines, panels, or wiring.

While our analysis estimated the prevalence and cost of pre-weatherization repairs, we did not attempt to do so for these pre-electrification upgrades. This is due to two reasons:

1. **Missing electrical capacity data**: No systematic data exists on the electrical capacity of New York State buildings.[73]
2. **Uncertain electrical capacity requirements**: Heat pump technology is moving so quickly that it is impossible to predict what electrical capacity will be needed to electrify New York's building stock. Today, the typical 1,000 square foot NYC apartment only needs a small heat pump system, which requires about 30 amps of current at full load. While an apartment with only 40 amp service would still need an upgrade to meet the electrical code,[74] smart panels may obviate the need for this, and many buildings offer 60 amp service or above. And while induction stoves and window-unit cold-climate heat pumps used to require 240V lines, newer models[75] do not.

While some level of electrical upgrades will undoubtedly be necessary, the amount is currently impossible to estimate with any accuracy, and may be lower than expected due to rapid technological progress.

Fuel costs

While EULP contained detailed fuel consumption time series for thousands of buildings under each scenario, it did not contain fuel prices. We gathered prices for electricity, natural gas, propane, and fuel oil from a variety of sources.

73 See p. 16 of Urban Green Council's Going Electric report (Urban Green Council 2020).

74 *ibid.*, p. 17

75 See Impulse for 120V induction stoves, and Gradient for 120V cold-climate window-unit heat pumps.

For calculations involved NYCI scenario C and A, we scaled these fuel prices according to the cost increases derived by the method described in Section 4.3.

Electricity & Natural Gas

To make our analysis as accurate as possible, we assembled electricity and natural gas rates for standard residential customers for each utility in New York State. We did so by collecting dozens of customer bills representing each utility territory.

The resulting utility rate dataset can be viewed here.

Propane & Heating Oil

We gathered average propane and average heating oil cost for October 2023 across New York State from the Energy Information Administration:

fuel	unit	price
oil	gallons	$4.41
propane	gallons	$3.27

Technical description of costs

What follows is a mathematical description of how we applied the **up-front** and **fuel costs** described above to the **upgrade scenarios** formalized in Section 4.5.3.1:

Variable	Meaning
$C_k(\overrightarrow{b})$	The up-front cost for line item k in household as a function of household characteristics Note this is a function because most of the costs scale proportionately with e.g. square footage, BTUs, etc.
$C_{i,j}$	The cost to get household i all of the requisite line items for scenario j $C_{i,j} = \sum_{k \in K_{i,j}} C_k(\overrightarrow{b_i})$
s	Fuel type index (electricity, oil, propane or natural gas)
t	Month t (from 1 to 12)

Variable	Meaning
$F_{i,j,s,t}$	Usage by household *i* of fuel *s* in month *t* under scenario *j* (in kWh, gallons, etc)
l	Fuel rate forecast regime. For this report, we used only one, which is to set rates for all time to those in October 2023.
$P_{s,i,l}(x)$	The total cost of fuel *s* at quantity *x* for household *i* (based on its geographical location and utility company)
$T_{i,j}$	Annual cost of all fuels to household *i* under scenario *j* $$T_{i,j} = \sum_{s,t} P_{i,s,l}(F_{i,j,s,t})$$

Subsidies

Federal subsidies: Inflation Reduction Act grants

Many states are looking to the subsidies within the Inflation Reduction Act to fund building decarbonization investments. In order to understand how big of an impact these subsidies would have, we had to incorporate them into our model.

Under the IRA's HER and HEEHRA programs, New York State will receive a combined total of $317 million in federal funds to spend on LMI building decarbonization. Given that these are one-time grants, and that New York will require several billion dollars *a year* in revenue for building decarbonization, we excluded these subsidies from our analysis.

Federal subsidies: Inflation Reduction Act tax credits & deductions

We did however apply IRA tax credits and deductions that cover envelopes, heat pumps, and heat pump hot water heaters:

- For owner-occupied units, the 25C Residential Energy Efficiency tax credit covers 30% of heat pumps, heat pump water heaters, and weatherization measures, up to $3,200 per year. That data can be viewed here.
- For renter-occupied units[76], the 179D Energy Efficient Commercial Buildings Deduction provides per-square foot tax deductions for envelopes, heat pumps, and heat pump

76 In multi-family buildings of four or more stories, including those owned by non-profits or governments.

hot water heaters: $0.50 per square foot for buildings that achieve at least 25% energy savings with these measures, with an additional $0.02 per square foot for each percentage point of savings above 25%, for a maximum of $1 per square foot for 50% energy savings.

Federal subsidies: tax liability calculation

Since residential tax credits for homeowners can only be fully claimed by households with sufficient tax liability, we had to estimate each household's federal income tax burdens.

We used the TAXSIM 35 model (Feenberg and Coutts 1993), via the `R` package usincometaxes; we assume that households with two persons are married, and that those with $n > 2$ people are married, filing jointly, and with $n - 2$ dependents.

Area Median Income

Since the subsidy a household receives under the incentive program is based on their income level (see Section 4.5.1.4), and income levels are defined as percentage of Area Median Income (AMI), we needed to determine how each household's income compared to their area's median income.

Because the EULP data uses 2021-vintage income data from the American Community Survey, we used 2021 AMI statistics from the federal Department of Housing and Urban Development (HUD) to define our income buckets. The LMI income cutoff (80% of AMI) we used for every county and household size can be viewed here.

State subsidies: New Efficiency: New York (NENY)

We summed the proposed New Efficiency: New York (NENY) spending for 2026 – 2030 for the Residential (LMI and market-rate) and Multifamily (LMI and market-rate) market segments to arrive at a total dollar figure for residential decarbonization. To estimate spending for years outside this range, we used a linear model to extend the data, covering 2025 - 2035. This assumes spending changes at a steady rate over time based on the trend in the 2026 – 2030 data.

State subsidies: NYCI residential decarbonization incentive revenue

Our estimate of the available revenue for residential decarbonization is 23% of NYSERDA's revenue projections under scenarios C and A. Unlike NYSERDA's spending package in their NYCI pre-proposal, we do not further divide that amount into market-rate and LMI portions.[77]

77 See slide 21 of NYSERDA's NYCI Pre-Proposal Preliminary Analysis (NYSERDA and DEC 2024).

Technical description of subsidies

We now finish our model's technical description, by formalizing our subsidy calculations given the upgrade scenarios from Section 4.5.3.1 and the costs from Section 4.5.5.3:

Variable	Meaning
$\overrightarrow{h_i}$	Vector of information on household members, such as income, number of persons, county and so on
$m\left(\overrightarrow{h_i}\right))$	The income category of the household, e.g. LMI, middle income, high income
$G(m)$	The goal payback period, in years, as a function of income category
$D(\overrightarrow{h_i})$	Federal income tax, as a function of household income and number of persons
$I(D, \overrightarrow{h_i}, C_{i,j})$	Federal tax subsidy from the Inflation Reduction Act (IRA), as a function of federal income tax, household income, and cost of upgrades under scenario j
$S_{i,j}$	The subsidy required to hit the payback period goal. If $T_{i,j} > = T_{i,0}$ for all $j \neq 0$, then household i has no scenario which saves money and so they are exempt from this program, and $S_{i,j}$ is undefined. Otherwise, $T_{i,j} < T_{i,0}$ for some j, and there are scenarios which save money yearly for the household. For these scenarios subsidy required is $S_{i,j} = \min(0, (C_{i,j} - C_{i,0}) - G(m) \cdot (T_{i,j} - T_{i,0}) - I(D, h_i, C^{i,j}))$
S_i	The chosen subsidy for a particular household, selecting the scenario with the lowest subsidy which hits the payback goal and still saves money. $S_i = \min_j \{S_{i,j} \mid T_{i,0}, j \neq 0\}$

The formula for $S_{i,j}$ follows the logic laid out in Section 4.5.1.4; the subsidy is what remains after accounting for the cost to upgrade, the tax benefits, and the yearly savings times the number of required years.

Income limits

In this section, we list out the annual income cutoffs that define AMI-based income levels in New York, according to HUD.

Income limit for full rebate eligibility (USD 2024)										
	Household Size									
	1	2	3	4	5	6	7	8	9	10
State	$35,370	$40,410	$45,450	$50,490	$54,540	$58,590	$62,610	$66,660	$66,660	$66,660
Albany	$36,316	$41,504	$46,690	$51,878	$56,050	$60,186	$64,356	$68,494	$72,630	$76,768
Bronx	$45,334	$51,812	$58,288	$64,730	$69,918	$75,106	$80,294	$85,448	$90,636	$95,790
Dutchess	$37,942	$43,368	$48,794	$54,184	$58,524	$62,864	$67,206	$71,546	$75,852	$80,192
Kings	$45,334	$51,812	$58,288	$64,730	$69,918	$75,106	$80,294	$85,448	$90,636	$95,790
Nassau	$45,064	$51,506	$57,948	$64,356	$69,510	$74,664	$79,818	$84,972	$90,092	$95,246
New York	$45,334	$51,812	$58,288	$64,730	$69,918	$75,106	$80,294	$85,448	$90,636	$95,790
Orange	$37,942	$43,368	$48,794	$54,184	$58,524	$62,864	$67,206	$71,546	$75,852	$80,192
Putnam	$45,334	$51,812	$58,288	$64,730	$69,918	$75,106	$80,294	$85,448	$90,636	$95,790
Queens	$45,334	$51,812	$58,288	$64,730	$69,918	$75,106	$80,294	$85,448	$90,636	$95,790
Rensselaer	$36,316	$41,504	$46,690	$51,878	$56,050	$60,186	$64,356	$68,494	$72,630	$76,768
Richmond	$45,334	$51,812	$58,288	$64,730	$69,918	$75,106	$80,294	$85,448	$90,636	$95,790
Rockland	$45,334	$51,812	$58,288	$64,730	$69,918	$75,106	$80,294	$85,448	$90,636	$95,790
St. Lawrence	$45,064	$51,506	$57,948	$64,356	$69,510	$74,664	$79,818	$84,972	$90,092	$95,246
Suffolk	$45,064	$51,506	$57,948	$64,356	$69,510	$74,664	$79,818	$84,972	$90,092	$95,246
Westchester	$42,996	$49,132	$55,270	$61,406	$66,324	$71,240	$76,156	$81,074	$85,956	$90,872

Table 6: Income limits for full rebate eligibility.

Area Median Income (AMI) (USD 2024)										
	Household Size									
	1	2	3	4	5	6	7	8	9	10
State	$58,950	$67,350	$75,750	$84,150	$90,900	$97,650	$104,350	$111,100	$111,100	$111,100
Albany	$60,526	$69,172	$77,818	$86,464	$93,416	$100,310	$107,262	$114,156	$121,050	$127,946
Bronx	$75,558	$86,352	$97,146	$107,884	$116,530	$125,176	$133,822	$142,412	$151,058	$159,648
Dutchess	$63,238	$72,280	$81,322	$90,308	$97,542	$104,774	$112,008	$119,242	$126,420	$133,652
Kings	$75,558	$86,352	$97,146	$107,884	$116,530	$125,176	$133,822	$142,412	$151,058	$159,648
Nassau	$75,106	$85,844	$96,580	$107,262	$115,852	$124,442	$133,032	$141,622	$150,154	$158,744
New York	$75,558	$86,352	$97,146	$107,884	$116,530	$125,176	$133,822	$142,412	$151,058	$159,648
Orange	$63,238	$72,280	$81,322	$90,308	$97,542	$104,774	$112,008	$119,242	$126,420	$133,652
Putnam	$75,558	$86,352	$97,146	$107,884	$116,530	$125,176	$133,822	$142,412	$151,058	$159,648
Queens	$75,558	$86,352	$97,146	$107,884	$116,530	$125,176	$133,822	$142,412	$151,058	$159,648
Rensselaer	$60,526	$69,172	$77,818	$86,464	$93,416	$100,310	$107,262	$114,156	$121,050	$127,946
Richmond	$75,558	$86,352	$97,146	$107,884	$116,530	$125,176	$133,822	$142,412	$151,058	$159,648
Rockland	$75,558	$86,352	$97,146	$107,884	$116,530	$125,176	$133,822	$142,412	$151,058	$159,648
St. Lawrence	$75,106	$85,844	$96,580	$107,262	$115,852	$124,442	$133,032	$141,622	$150,154	$158,744
Suffolk	$75,106	$85,844	$96,580	$107,262	$115,852	$124,442	$133,032	$141,622	$150,154	$158,744
Westchester	$71,658	$81,888	$92,116	$102,344	$110,540	$118,734	$126,928	$135,122	$143,260	$151,454

Table 7: Area Median Income (AMI) per county. We used the state median as the minimum values, only counties where AMI was greater than the state median are shown here.

Income limit for partial rebate eligibility (USD 2024)										
	Household Size									
	1	2	3	4	5	6	7	8	9	10
State	$106,110	$121,230	$136,350	$151,470	$163,620	$175,770	$187,830	$199,980	$199,980	$199,980
Albany	$108,946	$124,510	$140,072	$155,636	$168,148	$180,558	$193,070	$205,480	$217,892	$230,302
Bronx	$136,004	$155,434	$174,862	$194,190	$209,754	$225,316	$240,880	$256,342	$271,906	$287,368
Dutchess	$113,828	$130,104	$146,380	$162,554	$175,574	$188,594	$201,616	$214,636	$227,554	$240,576
Kings	$136,004	$155,434	$174,862	$194,190	$209,754	$225,316	$240,880	$256,342	$271,906	$287,368
Nassau	$135,190	$154,518	$173,844	$193,070	$208,532	$223,994	$239,456	$254,918	$270,278	$285,740

Income limit for partial rebate eligibility (USD 2024)										
	Household Size									
	1	2	3	4	5	6	7	8	9	10
New York	$136,004	$155,434	$174,862	$194,190	$209,754	$225,316	$240,880	$256,342	$271,906	$287,368
Orange	$113,828	$130,104	$146,380	$162,554	$175,574	$188,594	$201,616	$214,636	$227,554	$240,576
Putnam	$136,004	$155,434	$174,862	$194,190	$209,754	$225,316	$240,880	$256,342	$271,906	$287,368
Queens	$136,004	$155,434	$174,862	$194,190	$209,754	$225,316	$240,880	$256,342	$271,906	$287,368
Rensselaer	$108,946	$124,510	$140,072	$155,636	$168,148	$180,558	$193,070	$205,480	$217,892	$230,302
Richmond	$136,004	$155,434	$174,862	$194,190	$209,754	$225,316	$240,880	$256,342	$271,906	$287,368
Rockland	$136,004	$155,434	$174,862	$194,190	$209,754	$225,316	$240,880	$256,342	$271,906	$287,368
St. Lawrence	$135,190	$154,518	$173,844	$193,070	$208,532	$223,994	$239,456	$254,918	$270,278	$285,740
Suffolk	$135,190	$154,518	$173,844	$193,070	$208,532	$223,994	$239,456	$254,918	$270,278	$285,740
Westchester	$128,986	$147,396	$165,808	$184,220	$198,970	$213,720	$228,470	$243,220	$257,868	$272,618

Table 8: Income limits for partial rebate eligibility.

ASSUMPTIONS

Here's the full list of assumptions behind our analysis:

- **All cars are gas powered**: We did not estimate the likelihood of EV ownership. All households are assumed to drive gas cars.
- **No increase in cost of electricity** : We assume NYCI has no impact on the cost of electricity.
- **No increase in cost of goods as a result of NYCI**: Increased fuel costs have the potential to increase the overall cost of goods. We assume this does not happen under NYCI because the costs are isolated to the state of New York.
- **No utilities credit for LMI households**: under the Energy Affordability Program (EAP), many LMI households are eligible to receive utility credits lowering their overall energy bill. We did not account for this in our models.
- **Costs remain fixed**: While heat pumps are expected to get cheaper, and fuel prices are notoriously volatile, we did not

attempt to forecast up-front and fuel costs, but assume these costs are static through 2070.

- **IRA credits are renewed**: The IRA's 25C tax credit is currently set to expire on December 31, 2032. We assume the tax credit will be renewed due to the program's popularity. We also expect that 179D, covering rental properties, will be maintained.
- **Households pay for everything**: We assume that all households pay for upgrades/repairs and electric/natural gas/delivered fuel bills, as opposed to those charges being baked into their rent, or paid for by landlords.
- **Households receive subsidies**: We also assume that households always receive full federal and state incentives, even in the case of renters (see below).
- **Renters vs. owners**: To comply with the two preceding assumptions, we assume that landlords pass upgrade/repair/bill costs to tenants in the form of higher rent, and tenants receive subsidies to cover the costs of upgrades and repairs. In reality:
    - Landlords pay for upgrades and repairs, so they would be the subsidy recipients, for e.g. 179D tax credits.
    - Tenants typically pay for electric bills. Natural gas/delivered fuel are sometimes paid by tenants, and sometimes by landlords. In the latter case, installing heat pumps would shift heating bill payments from landlords to tenants. Our analysis ignores this possibility by assuming that tenants were already paying for heating through higher rent.
    - Since this may not be the case for many low-income tenants, New York State should adopt policies to guard against this **cost-shifting**.
- **Out-of-pocket costs paid with cash, not loans**: We assume that households pay after-subsidy up-front upgrade costs with cash. In practice, many households would take out loans. In this scenario, the loan's interest rate would affect the household's payback period, and therefore, by definition, the up-front subsidy they would receive.

- **Inflation and NPV**: All dollar values are presented in 2024 dollars. We do not consider net present value for any time series.
- **100% adoption**: We present results as though every boiler or furnace that reached end of life were replaced with a heat pump, as long as that household would have energy savings. While assuming 100% participation is not realistic, unless New York implements an appliance phase-out mandate, it provides an upper bound on the cost of the program.
- **No behavioral response to higher prices**: We do assume households do not respond to higher fossil fuel prices by reducing energy use or retiring their boiler and furnace early. Instead we show the paths of baselines energy consumption and fully decarbonized scenarios. In reality, households will likely fall somewhere in between.
- **NYCI compliance costs passed to consumers**: We assume that distributors of natural gas, gasoline, and delivered fuels will pass on the entire cost of purchased allowances to consumers.
- **NYSERDA's revenue projections are accurate**: We use NYSERDA's revenue projections for price ceiling scenarios A and C. These revenue projects are the result of complex modeling, and we inherit their assumptions.

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