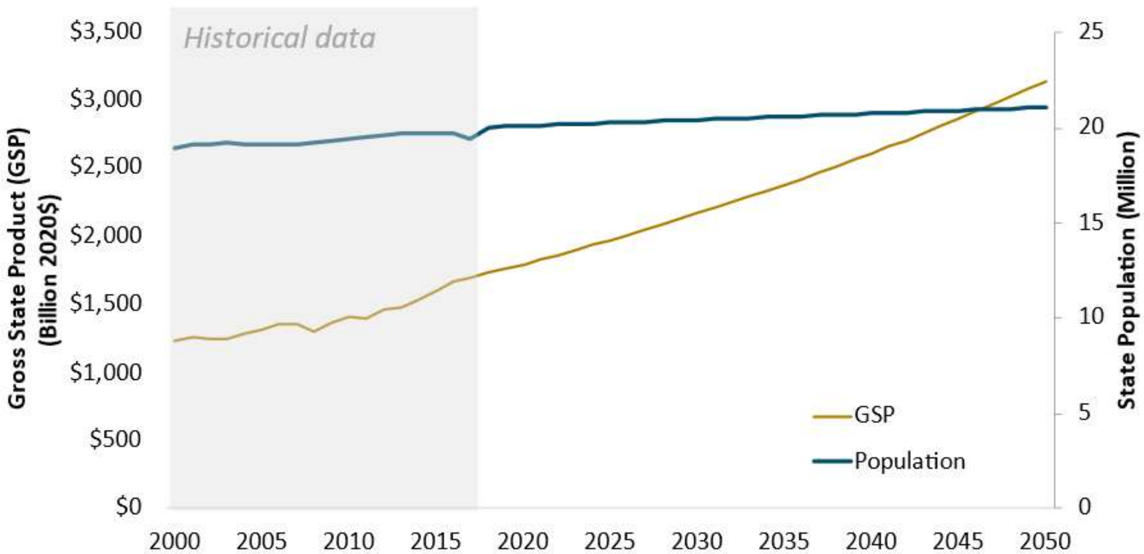
Chapter 10. Benefits of the Plan

10.1 Background

New York's economy has been steadily growing for the last two decades and state economic output per capita has been growing even more quickly. These trends are projected to continue over time (Figure 10).

Figure 10. Historical and Projected Population and Gross State Product



Source: NYSERDA Patterns and Trends, Federal Reserve Economic Data, Cornell Program on Applied Demographics.

Current annual system expenditure—the costs related to energy consumption in the state—to support New York's population and economy is estimated to be over $140 billion. This estimate includes capital investments for energy-consuming devices, liquid and gas fuel costs, and costs for in-State and imported electricity generation. While system expenditures are significant at over $140 billion, these make up a small share of gross state product (GSP; 8.9% in 2020, see Figure 11).

Of these total system expenditures, annual energy expenditures are approximately $50 billion, with over half of that amount (almost $30 billion) estimated to leave New York State.[192] Petroleum fuel expenditures are the largest single category at approximately $24 billion. Current energy expenditures outline the opportunity for import substitution through electrification, where a greater share of energy services is provided by in-State resources, driving economic activity and job creation.

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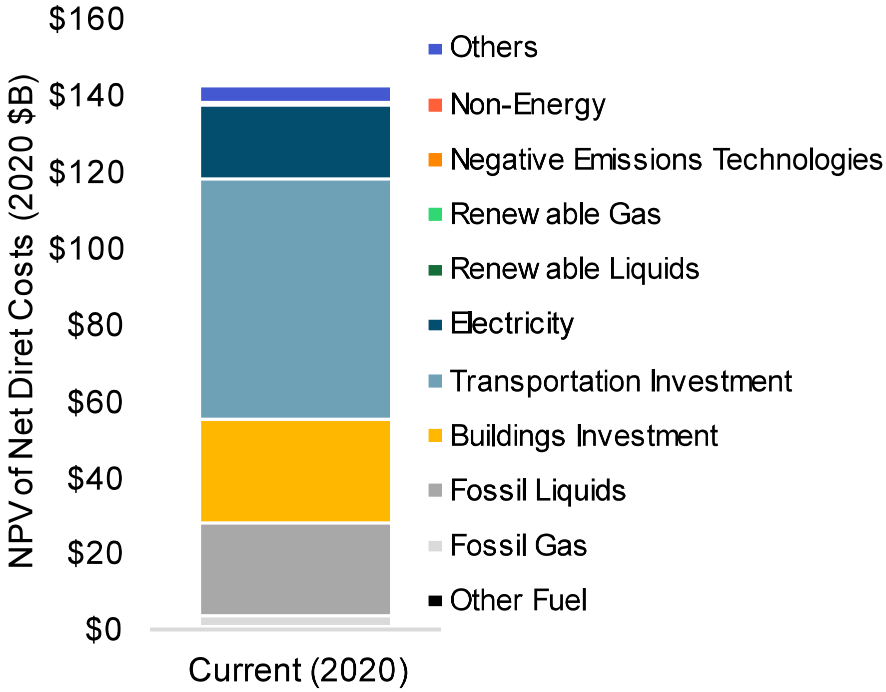
[192] NYSERDA. "New York State Energy Profile. Patterns and Trends." Accessed at https://www.nyserda.ny.gov/about/publications/ea-reports-and-studies/patterns-and-trends.

Figure 11. Estimated Current System Expenditure by Category



Note: Estimated system expenditures do not reflect direct costs in some sectors that are represented with incremental costs only. These include investments in industry, agriculture, waste, forestry, and non-road transportation.

10.2 Integration Analysis Benefit-Cost Approach

In addition to analyzing greenhouse gas (GHG) reductions, the integration analysis sought to quantify the costs and benefits of the mitigation scenarios described in *Chapter 9. Analysis of the Plan*. The quantified benefits include the value of avoided GHG emissions and avoided health impacts; cost categories include annualized capital, operations, and maintenance cost for infrastructure (such as devices, equipment, generation assets, and transmission and distribution) and annual fuel expenses by sector and fuel (conventional or low-carbon fuels, depending on scenario definitions).[193]

Value of Avoided GHG Emissions

All scenarios model significant GHG emissions reductions, which avoid the economic impacts of damages caused by climate change. The value of avoided GHG emissions calculations are based on the Value of Carbon guidance, developed by New York State Department of Environmental Conservation

[193] This analysis does not natively produce detailed locational or customer class analysis, but those may be developed through subsequent implementation processes. More specificity is needed around individual proposals in order to determine the impact on specific customers. The Council recommends that as proposals are advanced with additional implementation details, a complete consumer benefit-cost impact be performed to show the impact and inform program design prior to full implementation.

(DEC) pursuant to the Climate Act.[194] The value of these avoided GHG emissions is measured in each scenario relative to the Reference Case. GHG emissions were measured using value of avoided carbon dioxide (CO_2), avoided methane, avoided nitrous oxide (N_2O), and avoided hydrofluorocarbons (HFCs). For other GHGs, avoided emissions were converted to carbon dioxide equivalent (CO_2e) using the Intergovernmental Panel on Climate Change's (IPCC) AR5 20-year GWP values. The avoided GHG emissions time series in each year was multiplied by the annual social cost of GHG based on the DEC Value of Carbon guidance appendix, using the central case estimate for each GHG (2% discount rate for GHG emissions). More information on the approach to estimating the value of avoided GHG emissions can be found in the Integration Analysis Technical Supplement (Appendix G).

Value of Health Co-Benefits

The integration analysis also evaluated health benefits of mitigation scenarios relative to the Reference Case. For more information on these analyses, see Health Effects below. Three categories of potential health benefits were analyzed:

- Improvements in health outcomes due to improved air quality, including reduced incidence of premature mortality, heart attacks, hospitalizations, asthma exacerbation and emergency room visits, and lost workdays[195]
- Public health benefits from increased physical activity due to increased use of active transportation modes (such as walking and cycling) while accounting for changes in traffic collisions
- Estimated benefits of energy efficiency interventions in low- to moderate-income (LMI) homes

Integration Analysis Costs

The pathways framework produces economywide resource costs for the various mitigation scenarios relative to a reference case. The framework is focused on annual societal costs and benefits and does not track internal transfers (such as incentives). Outputs are produced on an annual time scale for the state of New York, with granularity by sector.

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[194] The value of avoided GHG emissions calculations are based on DEC guidance, which can be accessed at https://www.dec.ny.gov/regulations/56552.html.

[195] Health benefits are calculated as "High" and "Low." The economywide benefits applied the High case and the Low case are included in the uncertainty analysis. For more information, see Appendix G.

The integration analysis included calculations for three cost metrics: net present value (NPV) of net direct costs, annual net direct costs, and system expenditure. Cost estimates do not include estimates of federal funding available as per the Inflation Reduction Act, which is examined as a sensitivity.

- **NPV of Net Direct Costs:** This is the NPV of levelized costs in a given scenario incremental to the Reference Case from 2020 through 2050.[196] This metric includes incremental direct capital investment, operating expenses, and fuel expenditures.
- **Annual Net Direct Costs:** Net direct costs are levelized costs in a given scenario incremental to the Reference Case for a single year snapshot. This metric includes incremental direct capital investment, operating expenses, and fuel expenditures.
- **System Expenditure:** System expenditure is an estimate of absolute direct costs (not relative to the Reference Case). Estimates of system expenditure do not reflect direct costs in some sectors that are represented with incremental costs only. These include investments in industry, agriculture, waste, forestry, and non-road transportation.

Cost categories included in the metrics listed above are shown in Table 4. Cost outputs from the integration analysis are key inputs to the Jobs Study described *Chapter 7. Just Transition.*

Table 4. Integration Analysis Cost Categories

Cost Category	Description
Electricity System	Includes incremental capital and operating costs for electricity generation, transmission (including embedded system costs), distribution systems, and in-State hydrogen production costs.
Transportation Investment	Includes incremental capital and operating expenses in transportation (e.g., battery electric vehicles (EVs) and EV chargers)
Building Investment	Includes incremental capital and operating expenses in buildings (e.g., heat pumps and building upgrades)
Non-Energy	Includes incremental mitigation costs for all non-energy categories, including agriculture, waste, and forestry
Renewable Gas	Includes incremental fuel costs for RNG and imported green hydrogen
Renewable Liquids	Includes incremental fuel costs for renewable diesel and renewable jet kerosene

[196] All NPV calculations assume a discount rate of 3.6%. This discount rate was applied to all annual cost and benefit streams, including the value of avoided GHG emissions, which has an embedded, separate, and distinct perspective on discounting described in the DEC Value of Carbon guidance, which can be accessed at https://www.dec.ny.gov/regulations/56552.html.

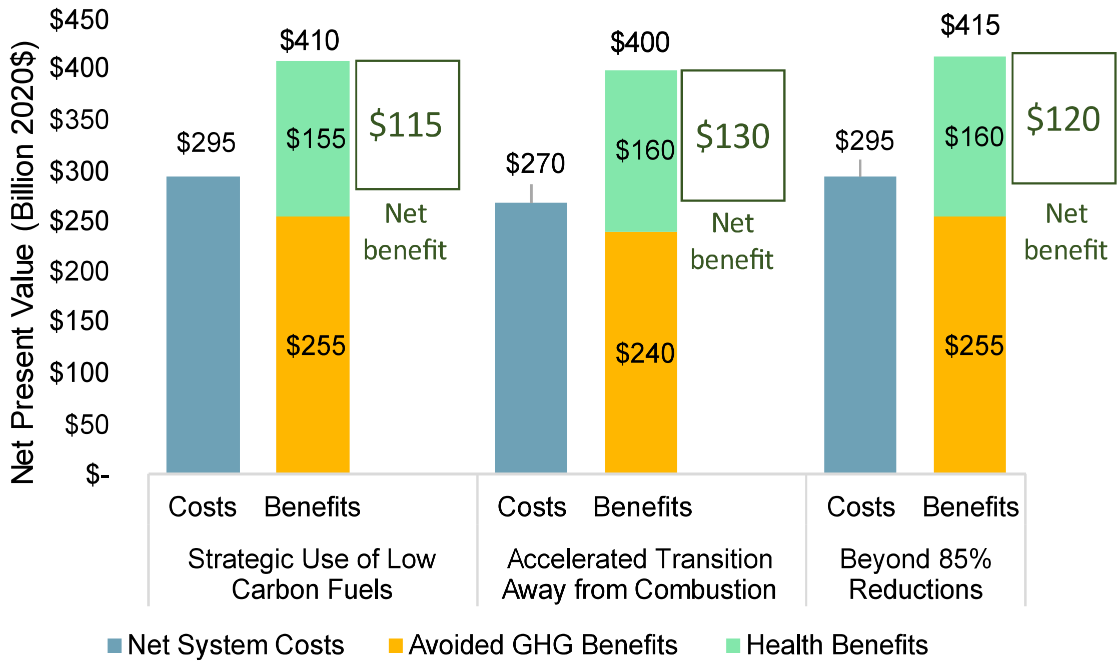
Cost Category	Description
Negative Emission Technologies	Includes incremental costs for direct air capture of CO_2 as a proxy for Negative Emission Technologies
Other	Includes other incremental direct costs including industry sector costs, oil & gas system costs, HFC alternatives, and hydrogen storage
Fossil Gas	Includes incremental costs spent on fossil natural gas (shown as a negative for cases when gas expenditures are avoided compared with the Reference Case)
Fossil Liquids	Includes incremental costs spent on liquid petroleum products (shown as a negative for cases when liquids expenditures are avoided compared with the Reference Case)
Other Fuel	Includes incremental costs spent on all other fossil fuels

10.3 Key Benefit-Cost Assessment Findings

The integration analysis assessed the benefits of avoided GHG emissions, health co-benefits, and resource costs for Scenario 2: Strategic Use of Low-Carbon Fuels, Scenario 3: Accelerated Transition Away from Combustion, and Scenario 4: Beyond 85% Reduction (Figure 12). There are three key findings from this assessment:

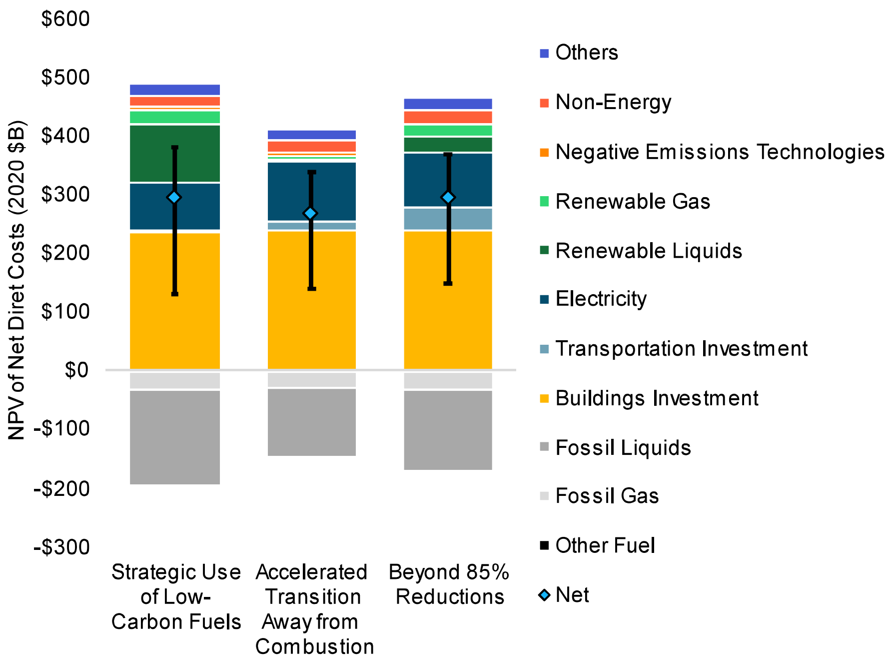
- **The cost of inaction exceeds the cost of action by more than $115 billion.** There are significant investments required to achieve Climate Act GHG emission limits, accompanied by even greater external benefits and the opportunity to create hundreds of thousands of jobs.
- **Net benefits range from $115 billion to $130 billion.** Improvements in air quality, increased active transportation, and energy efficiency interventions in LMI homes generates health benefits ranging from approximately $155 billion to $160 billion. Reduced GHG emissions avoids the economic impacts of damages caused by climate change equaling approximately $240 to $255 billion. The combined benefits range from approximately $400 billion to $415 billion.
- **Net direct costs are small relative to the size of New York's economy.** Net direct costs are estimated to be 0.5% to 0.6% of gross state product (GSP) in 2030, and 1.3% of GSP in 2050.
- **The Inflation Reduction Act will meaningfully reduce net direct costs.** New York could realize up to $70 billion of federal resources in support of the Scoping Plan initiatives through 2050, which would reduce incremental costs to New Yorkers by up to 19%.

Figure 12. Summary of Benefits and Costs (NPV Relative to Reference Case)



The NPV of net direct costs in Scenario 2, Scenario 3, and Scenario 4 are in the same range (due to uncertainty) and are primarily driven by investments in buildings and the electricity system (Figure 13). All scenarios show avoided fossil fuel expenditures due to efficiency and fuel-switching relative to the Reference Case (shown in the chart as negative costs). Scenario 2: Strategic Use of Low-Carbon Fuels includes significant investment in renewable diesel, renewable jet kerosene, and renewable natural gas (RNG). Scenario 3: Accelerated Transition Away from Combustion meets emission limits with greater levels of electrification, which results in greater investments in building retrofits, zero-emission vehicles, and the electricity system. Scenario 4: Beyond 85% Reduction builds on the electrification levels in Scenario 3, includes greater investments in transportation, waste, and agriculture sector mitigation, and layers back in a limited use of low-carbon fuels to reduce gross GHG emissions beyond the 2050 limit. Scenario costs are sensitive to the price of fossil fuels and technology cost projections, as reflected in error bars. The sensitivity bars shown in Figure 13 include low and high price sensitivities for fossil and low-carbon fuels and a range of technology costs for building technologies, transportation technologies, and direct air capture. New high fuel price and high technology cost sensitivities were performed in 2022 in light of global supply chain disruptions. The Inflation Reduction Act (not included here) will further reduce net direct costs. More detail on these sensitivities is included in section *10.4 2022 Cost Sensitivity Analysis*, below. The complete list of uncertainty and sensitivity analysis can be found in the Integration Analysis Technical Supplement (Appendix G).

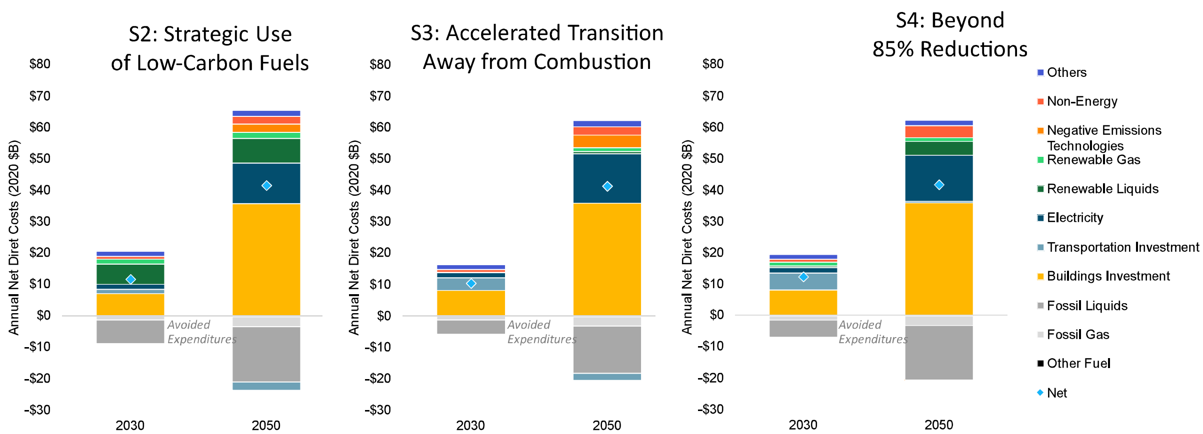
Figure 13. NPV of Net Direct Costs Relative to Reference Case (2020–2050)



Note: Uncertainty error bars include low and high fossil fuel price sensitivities and range of costs for heat pumps, EVs, wind, solar, storage, advanced renewable fuels, and direct air capture of CO_2. This figure does not include Inflation Reduction Act funding which further reduces net direct costs.

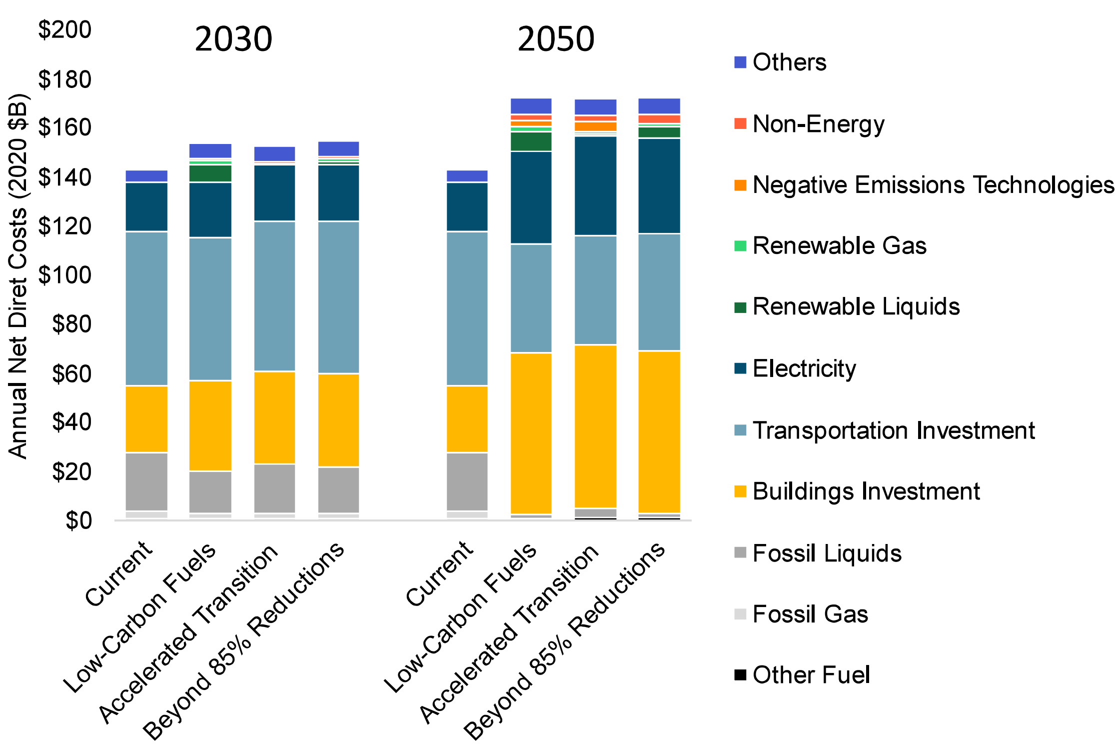
Annual net direct costs show the timing of key investments required to meet the Climate Act GHG emission limits. Scenario 2 includes significant investment in renewable diesel, renewable jet kerosene, and RNG starting in the mid-2020s. Scenario 3 includes greater levels of electrification compared with Scenario 2, which results in greater investments in building retrofits, zero-emission vehicles, and the electricity system. Scenario 4 layers on additional investments in transportation, agriculture, and waste mitigation relative to Scenario 3. Both scenarios 2 and 3 include investment in negative emissions technologies to achieve net zero emissions by 2050, whereas Scenario 4 does not require any negative emissions technologies due to the incremental investments in transportation, smart growth, agriculture, waste reductions. In 2030, annual net direct costs relative to the Reference Case are around $11 billion per year, approximately 0.5% of GSP; in 2050, costs increase to $41 billion per year, or 1.3% of GSP (Figure 14).

Figure 14. Annual Net Direct Costs Relative to Reference Case in Scenarios 2-4



Net direct costs were measured relative to the Reference Case, but system expenditures were evaluated on an absolute basis. System expenditures increase over time as New York invests in infrastructure and clean fuels to meet the Climate Act's emission limits. Compared with current estimated system expenditures, cost increases are moderate: 7% to 8% in 2030 and 20% to 21% in 2050 (Figure 15).

Figure 15. Annual System Expenditures in Scenarios 2-4



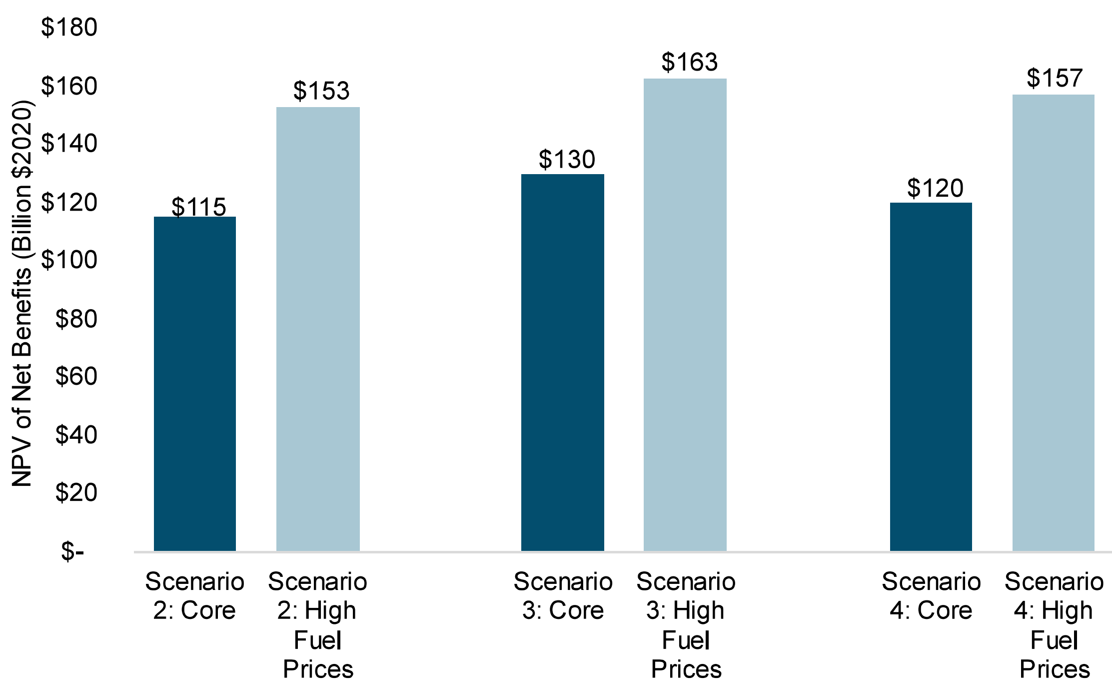
More detail on the benefit-cost assessment approach, input assumptions, results, uncertainty analysis, and sensitivity analysis is included in the Integration Analysis Technical Supplement (Appendix G).

10.4 2022 Cost Sensitivity Analysis

Since the publication of the draft Scoping Plan in 2021, the prices for several key technologies and fuels have changed due to a variety of factors such as global fuel market volatility and supply chain disruption. Additionally, the passage of the Inflation Reduction Act will lead to new incentives that can offset the cost of decarbonization. New sensitivities were performed in support of the Final Scoping Plan to consider the effects of these developments. More details are provided in Appendix G.

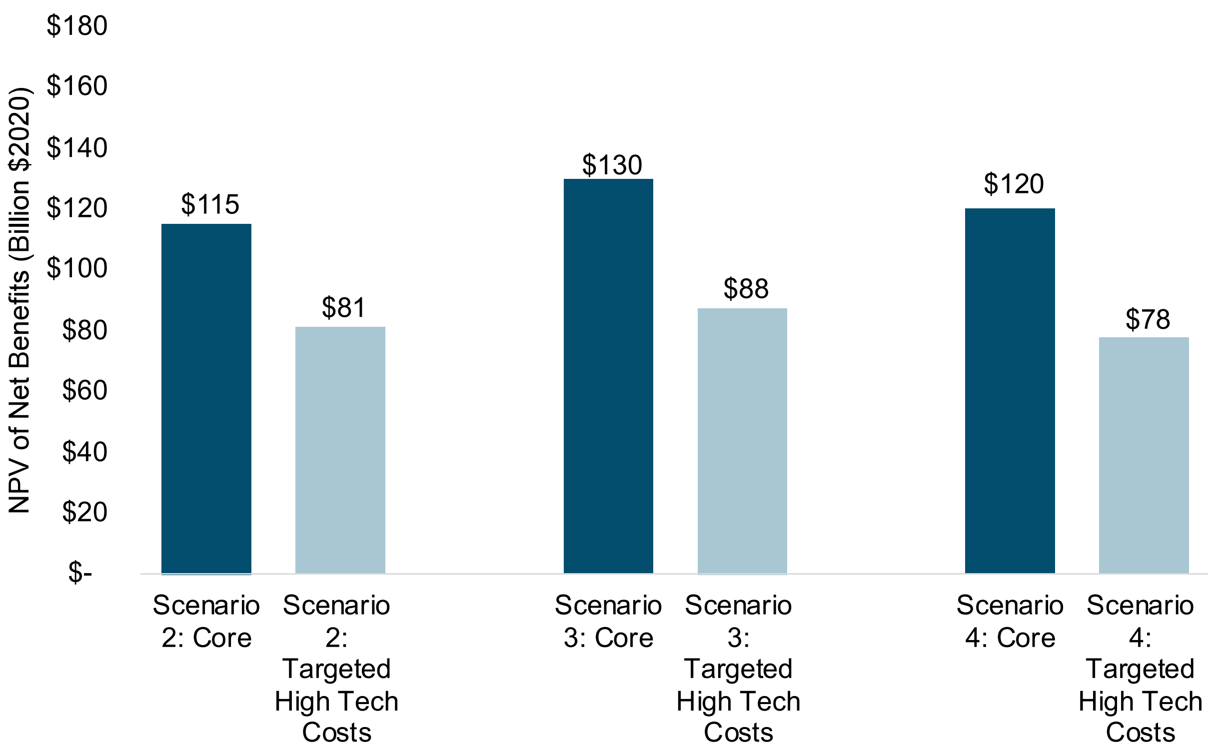
A high fuel price sensitivity evaluated the effects of the potential for persistently higher fossil fuel prices. The high fossil fuel prices increase the costs of all cases, with the largest increase in costs occurring in the Reference Case where a higher share of consumption remains fossil. This dynamic increased the net benefit of the mitigation scenarios by $33 to $38 billion compared with the original runs, which underscores the value of a transition to renewables to reduce exposure to higher fossil fuel prices (Figure 16).

Figure 16. Net Benefits: High Fuel Price Sensitivity



The draft Scoping Plan included a low technology cost sensitivity that explored the effects of more industry learning than what was included in the core cases. A new targeted high technology cost sensitivity was developed to explore the effects of higher prices for clean buildings and transportation technologies from near-term supply chain issues that could persist. These higher technology costs would particularly increase the costs of the mitigation scenarios, which have higher adoption of heat pumps and electric vehicles. This would reduce the net benefits of the mitigation scenarios by $34 to $42 billion compared with the reference case (Figure 17). Even under this targeted high technology cost sensitivity, all mitigation scenarios see significant net benefits relative to the Reference Case.

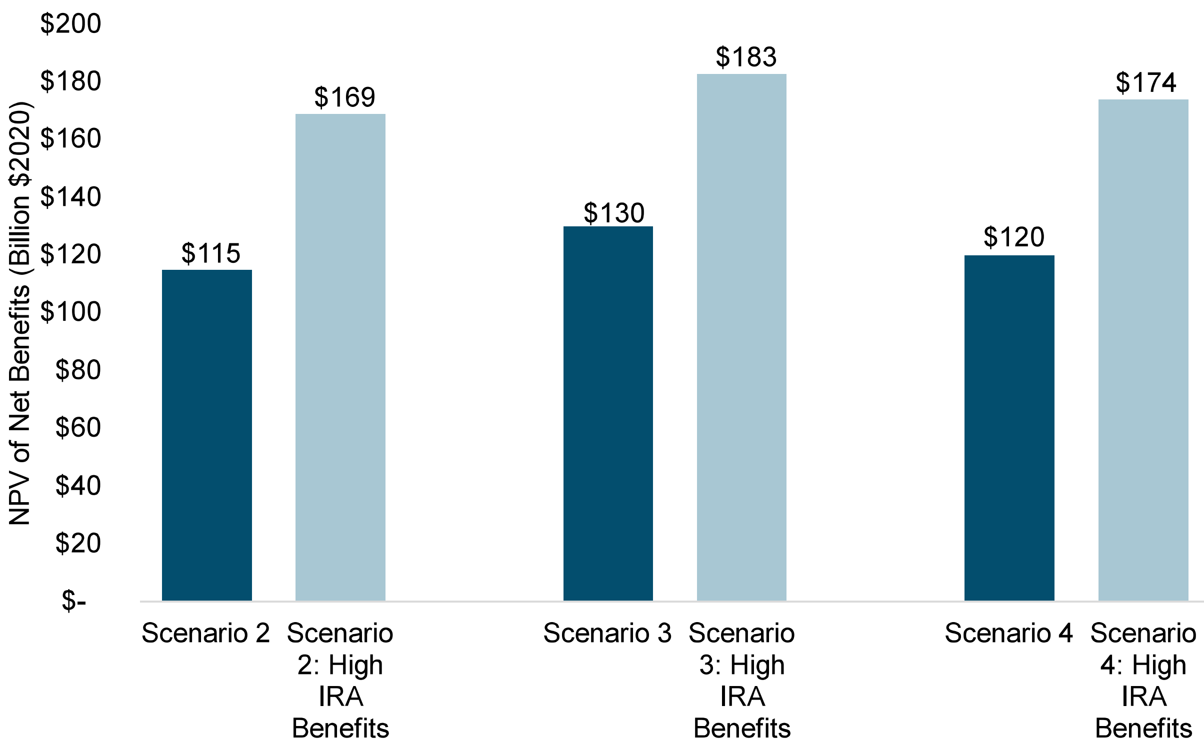
Figure 17. Net Benefits: Targeted High Technology Cost Sensitivity



The passage of the federal Inflation Reduction Act is a major policy development that will provide important funding that can offset the costs of decarbonization economywide. The full impacts of the act will take additional time to understand in more detail. To provide an initial estimate of the impact to New York, a new sensitivity was performed to estimate the federal funding that could be available to offset the cost to achieve Climate Act requirements and goals and the impact of this federal funding on scenario benefit-cost analysis. The modeling focuses on the largest climate and energy provisions with the clearest implications and considers a range of outcomes to reflect uncertainty for the impact of key parameters (e.g., domestic content provisions, income caps, tax liability). It does not model impacts of all funding (e.g., manufacturing grants, early-stage innovation, and block grants, which will play an important role in keeping New York on track and driving equitable outcomes but were too uncertain to model). In total, the Inflation Reduction Act could provide $41 to $69 billion to reduce the costs to New York to meet the requirements of the Climate Act.

The Inflation Reduction Act incentives are higher in the mitigation scenarios than in the Reference Case, due to greater adoption of clean technologies and fuels eligible for incentives (e.g., EVs, heat pumps, renewables, battery storage, and hydrogen). As a result, the Inflation Reduction Act increases net benefits of the Mitigation Scenarios by up to $50 billion, compared with the core 2022 net benefit results (Figure 18). Federal funding associated with the Inflation Reduction Act affects all sectors of the economy, with the majority of benefits accruing to electric generation, electric vehicles, building efficiency and electrification, and hydrogen and alternative fuels production. More details are provided in Appendix G.

Figure 18. Inflation Reduction Act Sensitivity Net Benefits



10.5 Health Effects

Health Analyses Approach Overview

The analysis of potential public health benefits associated with the decarbonization policy scenarios evaluated the potential for the scenarios to affect changes in public health outcomes relative to the

Reference Case. As discussed in *Chapter 9. Analysis of the Plan*, the scenarios modeled in the integration analysis have been updated between the draft and this final Scoping Plan. The public health analysis discussed below has been updated accordingly to reflect the changes in energy consumption in the integration analysis scenarios. One exception to this is that detailed electricity sector production modeling was not undertaken again for the health analysis. Based on the changes projected in the electricity generation mix between the draft and final Scoping Plans, the potential change in health benefits is estimated to be relatively minor, approximately 0.4% of the total health benefits. Three analyses were undertaken, evaluating the potential to:

- Improve air quality and ensuing health outcomes through reduced combustion and associated pollutant emissions
- Improve public health through increased activity associated with active transportation modes such as walking and cycling
- Improve health outcomes in homes, especially LMI homes, through energy efficiency interventions

The air quality analysis applied the U.S. Environmental Protection Agency's (EPA) CO Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool, customized with detailed inputs specific to New York State and the scenarios analyzed, to evaluate air quality and ensuing public health outcomes at the county level. COBRA evaluates ambient air quality based on emissions of direct fine particulate matter ($PM_{2.5}$) and its precursors (SO_2, VOC, and NO_X) and the ensuing changes in annual average total $PM_{2.5}$ concentrations. The results include 12 different health outcomes, such as premature mortality, heart attacks, hospitalizations, asthma exacerbation and emergency room visits, and lost workdays. Results are calculated as "High" and "Low," reflecting two alternative methods adopted by EPA for evaluating premature mortality and non-fatal heart attacks based on two epidemiological studies of the impacts of air quality on public health. The economywide benefit results described in the sections above applied the High case, and the Low case is included in the uncertainty analysis described in Appendix G. Note that COBRA does not include additional potential benefits from reduced ozone concentrations; the value of those benefits is estimated to be a few percent of the benefits associated with $PM_{2.5}$. Additional benefits not included are potential benefits associated with reduced NO_2 concentrations and reduced toxics, which were not evaluated given the high uncertainty and lack of sufficient data to provide reasonable estimates.

COBRA was applied to the Reference Case and the policy scenarios described above for 2020 through 2050 in five-year increments, and the value of the improved health outcomes was interpolated to estimate benefits for the entire period. The analysis includes emissions in all sectors and all states, and the effect of the scenarios on emissions in New York as well as any potential effect of changes in New York's electricity consumption on electricity generation in other states.

Potential public health benefits from increased physical activity due to increased use of active transportation modes, while accounting for potential increases in traffic collisions, were estimated using the Integrated Transport Health Impacts Model, customized to represent New York State.

Values from published literature on the health and safety benefits of energy system changes and weatherization programs in homes were used to estimate the potential benefits of energy efficiency interventions. These applied only to LMI homes expected to have upgraded systems and weatherization. While additional benefits may result from building changes in higher-income homes, those benefits would likely be less, and no data are available to estimate those details. For a detailed description of the health analyses methods, see Appendix G.

Key Health Findings

Decarbonizing New York can result in a substantial health benefits from improved air quality, on the order of $50 billion to $110 billion from 2020 through 2050 (based on reduced mortality and other health outcomes) relative to the Reference Case.

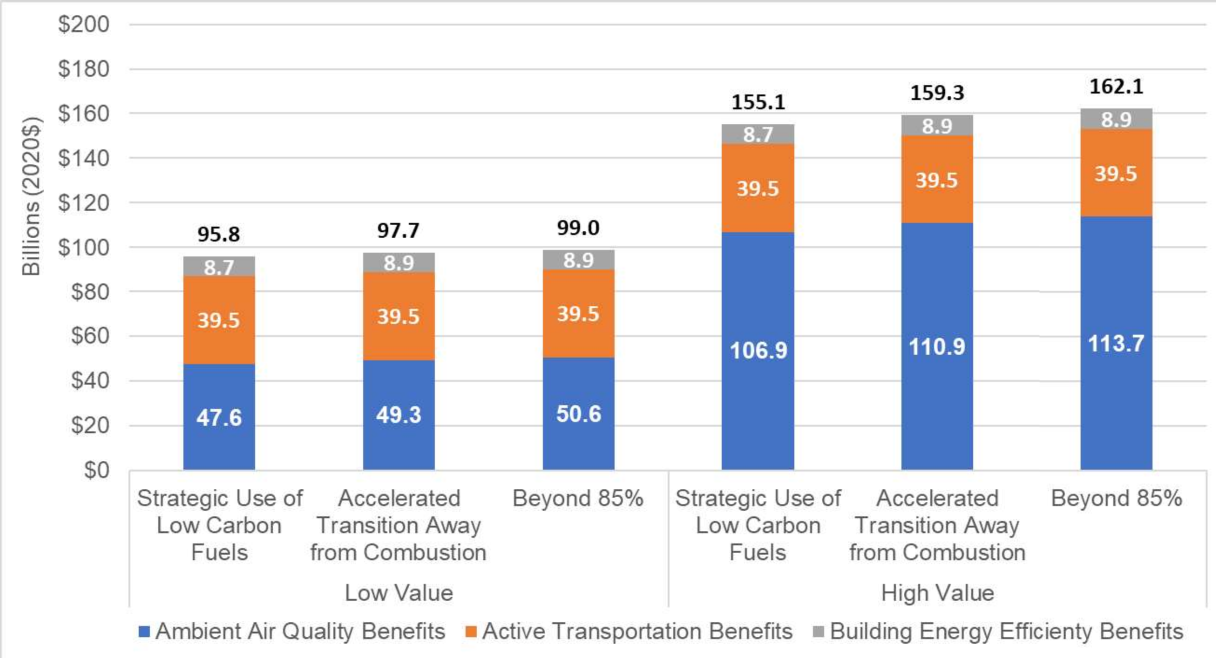
- Benefits would be experienced throughout the State and downwind in neighboring states.
- Benefits of reduced fossil fuel combustion would be higher in urban areas due to both higher emissions and larger impacted populations.
- Benefits of potentially reduced wood combustion would be higher in upstate areas.
- Annual benefits would grow over time as pollution rates decrease.

Two additional potential health benefit categories were estimated:

- $40 billion associated with the health benefits of increased active transportation (such as walking and cycling)
- $9 billion associated with energy efficiency interventions in LMI homes (additional benefits, not quantified, may occur in other buildings as well)

The total projected potential health benefits associated with the scenarios analyzed are presented in Figure 19. Results are presented for the High Value and Low Value cases.

Figure 19. Total Projected Health Benefits (NPV, 2020–2050)



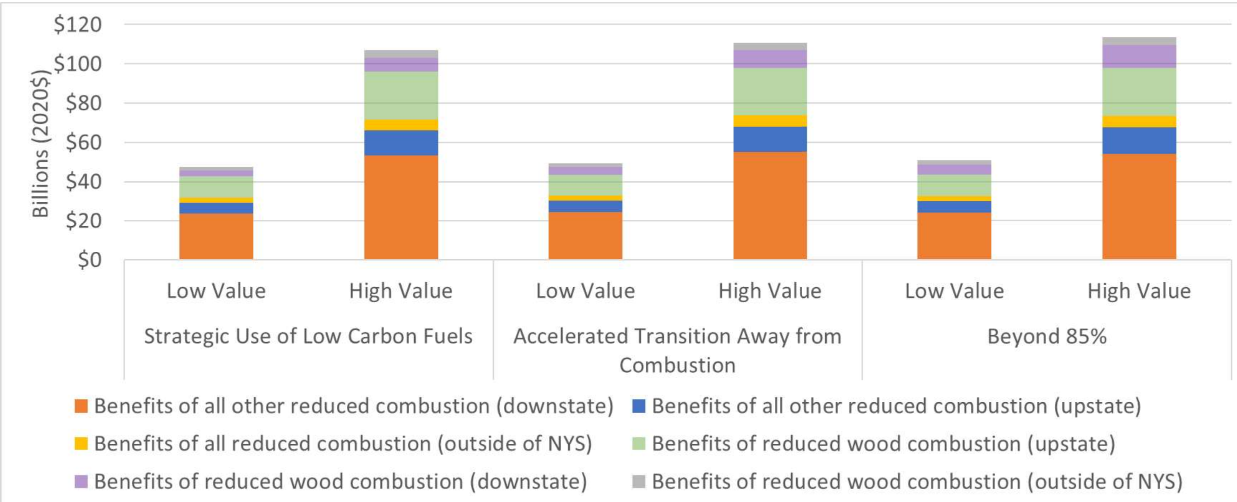
Ambient Air Quality Benefits

In all scenarios, air quality improvements can avoid tens of thousands of premature deaths, thousands of non-fatal heart attacks, thousands of other hospitalizations, thousands of asthma-related emergency room visits, and hundreds of thousands of lost workdays.

The value of the benefits by scenario are presented in Figure 20. While a small amount of benefits would occur downwind of New York in neighboring states, the vast majority of benefits would occur within New York. A large portion of the projected benefits would result from potential reductions in wood combustion. Benefits from reduced fuel combustion (excluding wood) would be larger downstate, and benefits from reduced wood combustion would be larger upstate. While the reduced wood combustion represents a small amount of the total reduced fuel combustion, it has an outsized impact on particulate matter emissions, resulting in substantially high health benefits.

Benefits would increase over time as policies affecting emission reductions take effect, gradually increasing up to approximately $6 billion in the Low case and under $14 billion in the High case by 2050.

Figure 20. Total Projected Ambient Air Quality Health Benefits (NPV, 2020–2050)



As presented in Figure 21, approximately 38% of the projected benefits are associated with reduced wood combustion in industrial, commercial, and residential uses. The remaining benefits are associated with relatively equal amounts from transportation (on-road and non-road) and building fuel combustion, and additional small fractions of the benefits are associated with reduced combustion in the electricity generation sector. While buildings and electricity generation have substantial emissions and ensuing health impacts locally, much of the building energy and power in New York is based on natural gas, which burns much cleaner and therefore has a substantially lower impact on particulate matter emissions and public health than oil. Oil combustion can have a much larger health impact locally, but the quantities of oil used statewide are much smaller. However, despite having lower particulate matter emissions than wood combustion overall, those oil and natural gas emissions from buildings do have a large impact on public health because they are in more populated urban areas, while wood combustion is more heavily weighted to rural areas with less dense population, resulting in similar health benefits from reducing wood and oil/gas (this is true also for renewable oil and gas). The benefits from substantially reducing or eliminating combustion in the electricity sector are on the order of 4%, and do not change materially in cases where limited hydrogen is combusted relative to non-combustion scenarios. For a sensitivity analysis of fuel options see Appendix G.

Figure 22 presents the annual health benefits (high value) by sector from the Strategic Use of Low-Carbon Fuels scenario, demonstrating the increasing benefits over time in all sectors. These sectoral results show that the majority of the benefits over time are due to emission reductions in the commercial and residential sector. In addition, these results show that the benefits from emission reductions in the electricity generation sector largely begin in 2040.

Figure 21. Health Benefits by Sector (2020–2050)

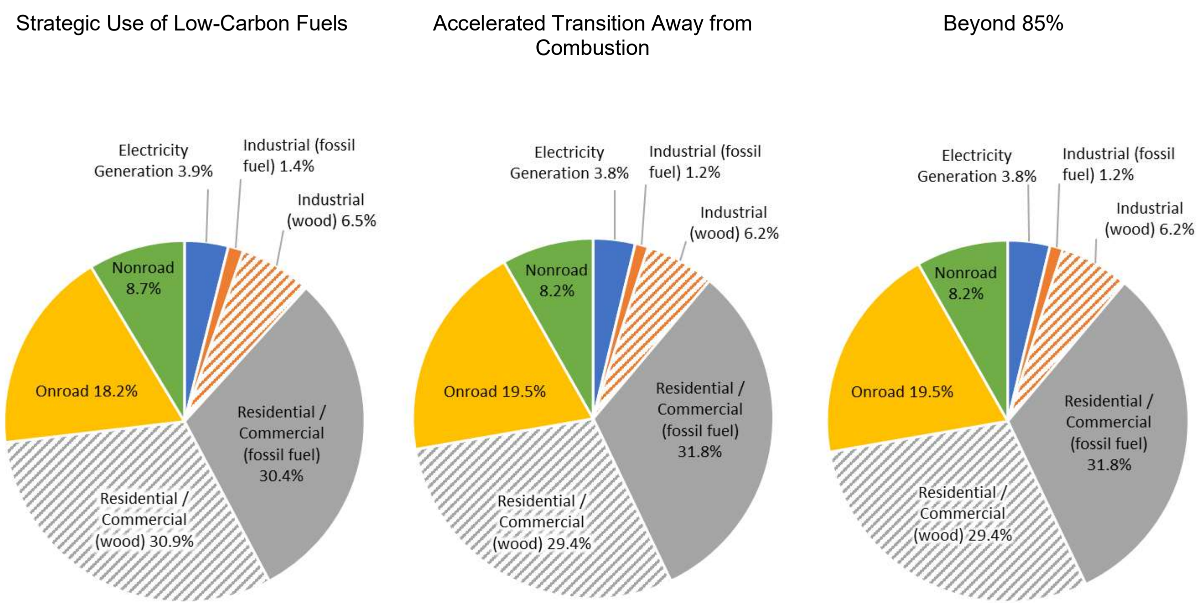
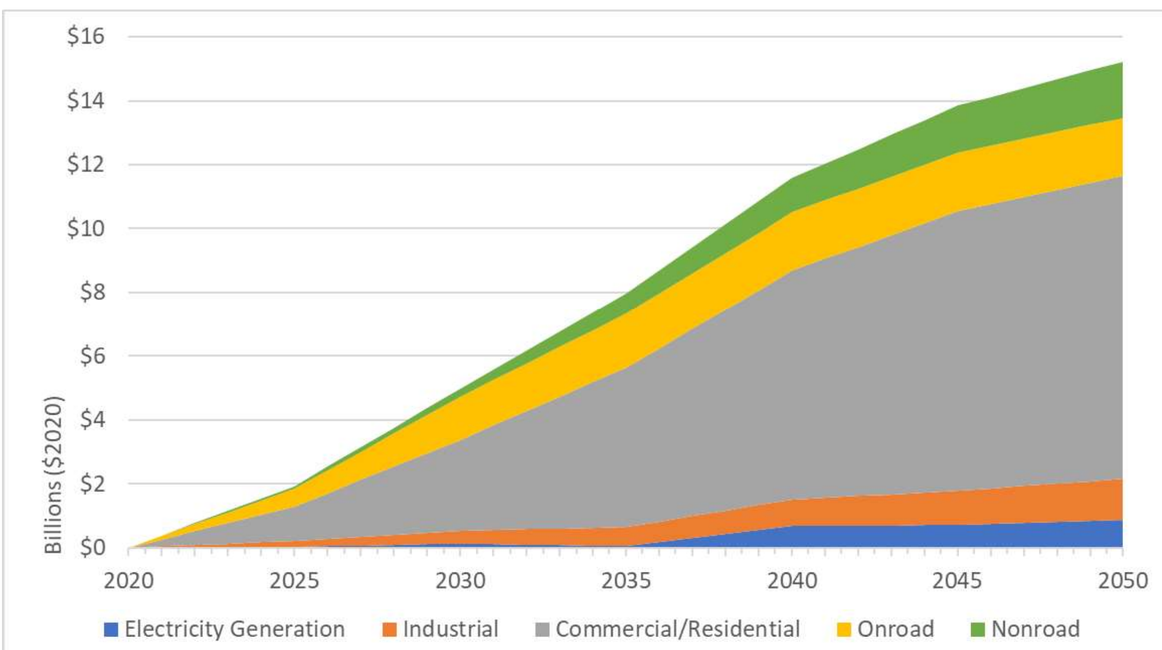


Figure 22. Annual Health Benefits by Sector (high value) for the Strategic Use of Low-Carbon Fuels Scenario



The maximum annual average $PM_{2.5}$ concentration reductions by county projected to be achieved by 2050 are presented in Figure 23. Note that the concentration reductions in all three scenarios are very similar. The distribution of benefits per capita are presented in Figure 24, both with and without the benefits of wood combustion. While much higher benefits overall would accrue in urban areas due to the higher population, per-capita benefits are also higher in urban areas due to higher baseline health incidence and larger reductions in emissions (due to larger sources available to be reduced). The distribution of benefits is very similar in all three scenarios.

Figure 23. Reduction in $PM_{2.5}$ Annual Average Concentrations, Strategic Use of Low-Carbon Fuels

<table>
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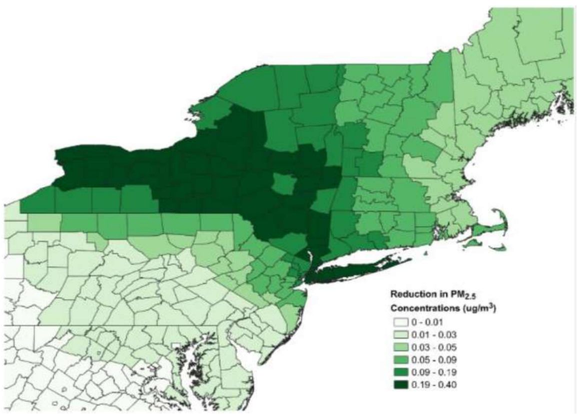
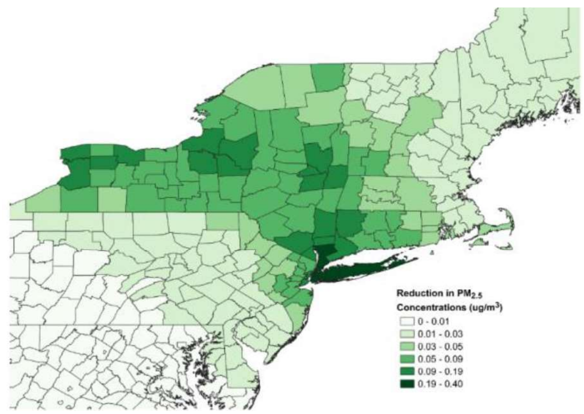
<tr><td>
</td><td>
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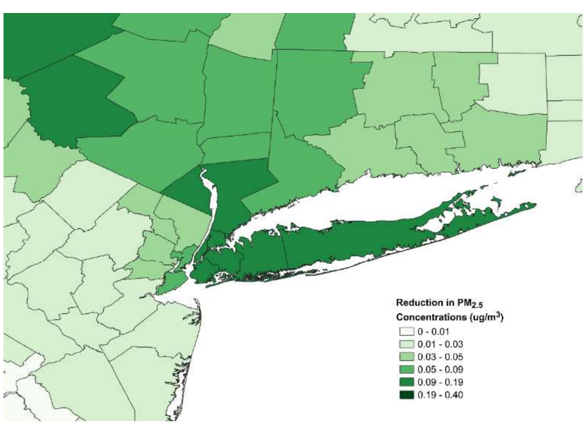
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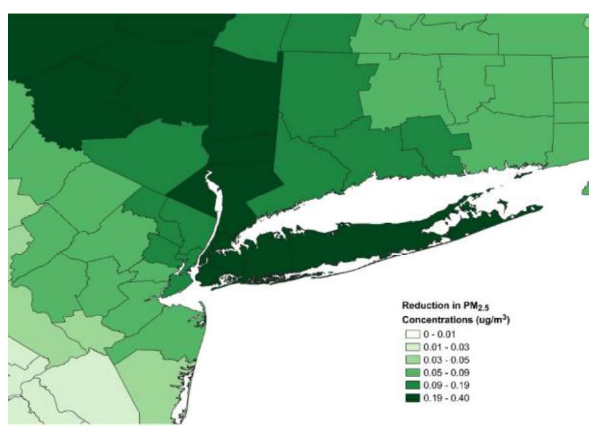
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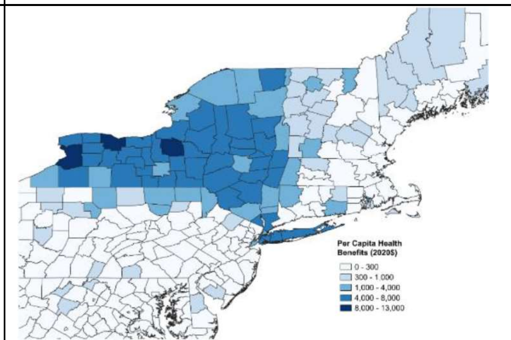
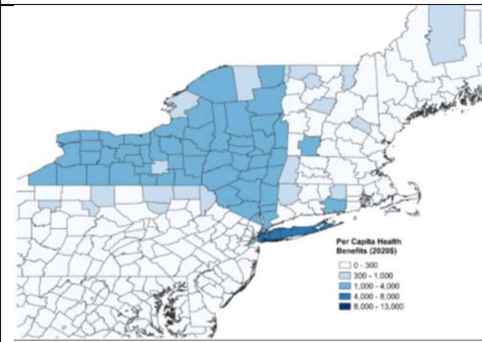
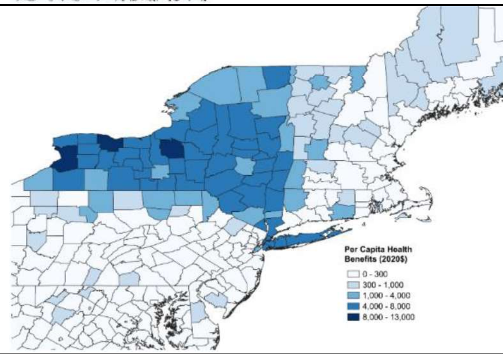
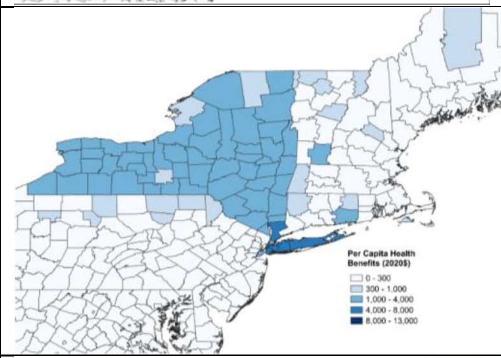
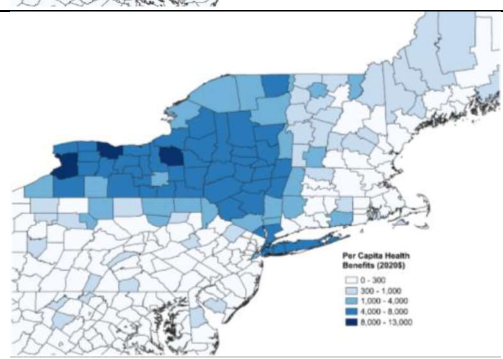
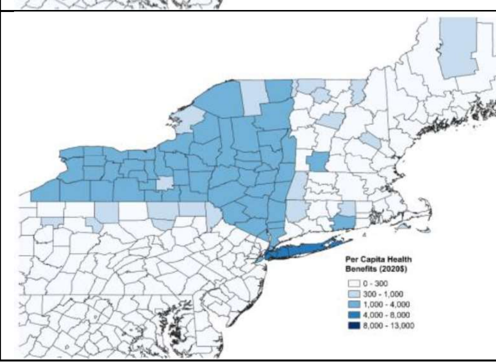
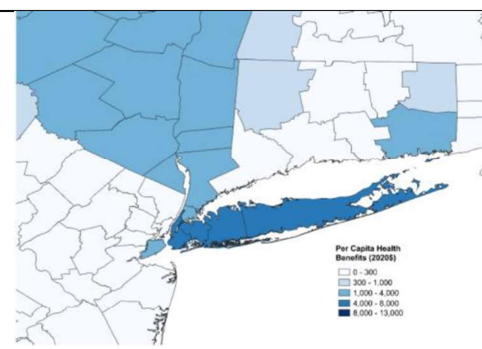
Figure 24. Per Capita Health Benefits (2020–2050)

Scenario	all fuels	excluding benefits of avoided wood combustion
Strategic Use of Low-Carbon Fuel		
Accelerated Transition Away from Combustion		
Beyond 85%		

New York City area – excluding benefits of avoided wood combustion

	Low-Carbon Fuels	Accelerated Transition	Beyond 85%
Bronx	$3,797	$4,045	$4,106
Brooklyn	$4,647	$4,848	$4,925
Manhattan	$5,521	$5,776	$5,915
Queens	$6,079	$6,319	$6,442
Staten Island	$3,355	$3,471	$3,562

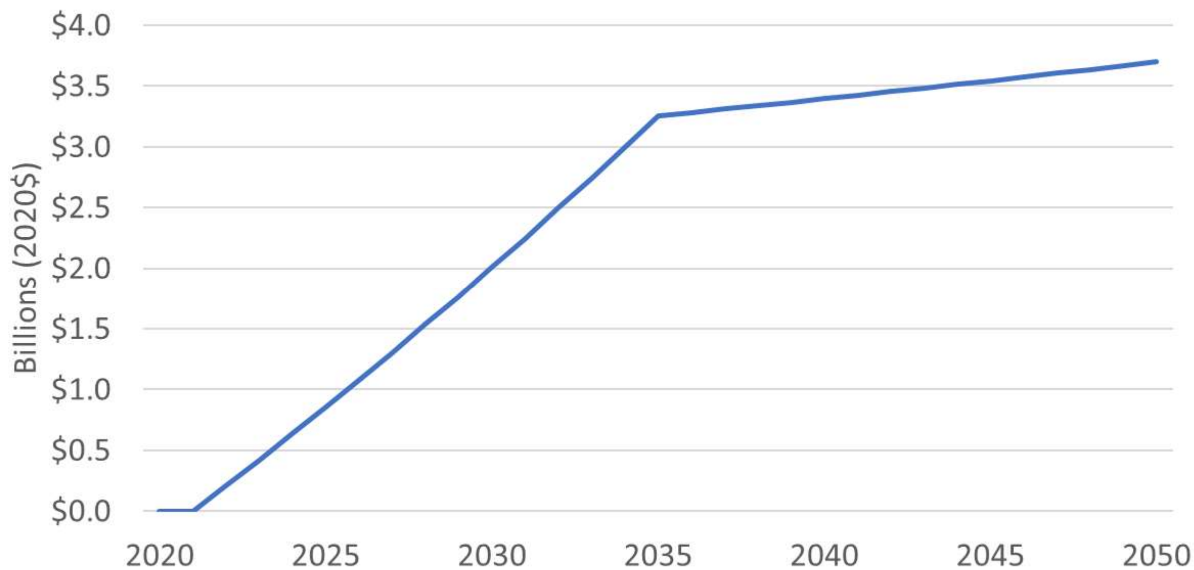


Health Benefits of Increased Active Transportation

The potential value of the net reduction in the number of deaths, including the decrease in deaths from increased physical activity and the increase in deaths from traffic collisions, is estimated to be a NPV of

$39.5 billion (2020 to 2050). As presented in Figure 25, the values increase over the years as walking and cycling increases with the introduction of infrastructure and other measures to encourage the use of these modes. Note that the projected decrease in premature deaths from physical activity far outweighs the potential increase in deaths from traffic collisions. Active transportation benefits are the same for the Low-Carbon Fuels and Accelerated Transition scenarios.

Figure 25. Potential Annual Value of Public Health Benefits from Increased Active Transportation



Health Benefits of Residential Energy Efficiency Interventions

Health benefits in residential energy efficiency interventions are expected to result from several factors listed in Table 5. These do not include all the potential benefits, but rather only those for which sufficient study of benefits per intervention was available to apply to the New York scenarios. Not included, for example, are the benefits of indoor air quality associated with reduced indoor combustion of gas for cooking. Indoor air quality improvements can be achieved by ensuring appropriate ventilation (often in cases where ventilation and existing conditions were not appropriate prior to the intervention) combined with heat recovery where needed. Crucial to this benefit is ensuring appropriate ventilation when tightening building envelopes.

Table 5. Health Benefits Included in the Analysis of Residential Energy Efficiency Interventions

Health-Related Measure	Causes for Each Benefit	Low-Income Single Family	Low-Income Multifamily
Reduced thermal stress – heat and cold	Building envelope tightening, appliance replacements	☑	☑
Reduced asthma-related incidents or reduced asthma symptoms	Improved ventilation	☑	*
Reduced trip or fall injuries	Removal of trip hazards, roofing improvements, lighting improvements	☑	☑
Reduced carbon monoxide poisonings	Appliance replacements, carbon monoxide monitors	☑	Not available

**This was studied but no significant difference was detected.*

In many cases, benefits occur due to programs ensuring that associated measures are taken at the same time, such as ensuring that carbon monoxide monitors are available where needed and that weatherization does not happen prior to fixing existing conditions such as mold.

The analysis was undertaken at high-level, applying the number of homes to average benefits from the existing studies. Benefits were estimated only for LMI homes. There are likely also benefits for higher income homes, but data to estimate those benefits is not available.

Benefits would be highly dependent on the structure of the interventions. Energy efficiency programs differ based on whether they include appliance replacement, building shell retrofits, or other non-energy interventions (such as installing carbon monoxide detectors).

Following the current practice in New York State Energy Research and Development Authority's (NYSERDA) energy efficiency programs, the analysis assumes that a range of non-energy measures would be included as appropriate in each case.

The projected benefits by health measure and building type are detailed in Table 6 and Table 7 for the Strategic Use of Low-Carbon Fuels and the Accelerated Transition Away from Combustion, respectively.

Table 6. Potential Public Health Benefits of Energy Efficiency Intervention (2020–2050) — Strategic Use of Low-Carbon Fuels

Health-Related Measure	LMI Single-Family (billion $)	LMI Multifamily (billion $)	Total (billion $)
Reduced asthma-related incidents or reduced asthma symptoms	$3.0	Not available	$3.0
Reduced trip or fall injuries	$1.4	$0.5	$1.9
Reduced thermal stress – cold	$0.4	$0.9	$1.2
Reduced thermal stress – heat	$0.6	$1.5	$2.2
Reduced carbon monoxide poisonings	$0.5	Not available	$0.5
Total	**$5.8**	**$2.9**	**$8.7**

Table 7. Potential Public Health Benefits of Energy Efficiency Intervention (2020–2050) — Accelerated Transition Away from Combustion

Health-Related Measure	LMI Single Family (billion $)	LMI Multifamily (billion $)	Total (billion $)
Reduced asthma-related incidents or reduced asthma symptoms	$3.0	Not available	$3.1
Reduced trip or fall injuries	$1.4	$0.5	$1.9
Reduced thermal stress – cold	$0.4	$0.9	$1.3
Reduced thermal stress – heat	$0.6	$1.6	$2.2
Reduced carbon monoxide poisonings	$0.5	Not available	$0.5
Total	**$5.9**	**$3.0**	**$8.9**