Zero Carbon New-Construction Codes: Impacts on Criteria Pollutants in New York

Jim Edelson *Member ASHRAE*

Jodi Smits Anderson, FAIA

Grant Sheely *Member ASHRAE*

Tristan Grant *Member ASHRAE*

ABSTRACT

The widespread positioning of 'zero carbon' as a performance goal for building energy codes has been a powerful tool for meeting climate policy goals and for setting long-term market signals in the building industry worldwide. Zero carbon codes drive both high levels of energy efficiency in new construction as well as drive designs that facilitate the use of low or zero carbon fuels, principally renewable electricity. Highly efficient designs and very low carbon designs both affect the level and geographic distribution of criteria pollution created in powering the buildings over their lifetimes. This impact has been recognized by the NY Legislature which in 2022 passed legislation specifying that societal impacts of criteria pollution resulting from designs delivered by future energy codes in NY could be considered in calculations determining the cost-effectiveness of a proposed code. The paper will survey how building codes impact criteria pollution, both in a building-level design decision framework and on a jurisdiction-wide health impact basis. Societal impacts in disadvantaged communities (DAC) will be analyzed to discover health and health-cost disparities caused by energy code adoptions. The paper will also explore how future policies can ensure that zero carbon codes encourage fuel-type usage patterns and minimize pollution health impacts. Finally, the authors will propose and encourage analytical frameworks and terminology to advance the use of criteria pollution and health in cost-effectiveness and other code evaluation methodologies.

INTRODUCTION

Since the 1970s, energy codes have primarily been concerned with energy conservation and energy efficiency. Most of the decisions about which efficiency measures to include in each subsequent version of energy code have been determined by how much energy use can be reduced cost-effectively – with the savings of energy bills generally compared against first costs of energy improvements. Of course, the energy equation that codes are trying to solve today is more complex, and the policy objectives energy codes are trying to solve for are just as likely to be for greenhouse gas performance as for energy performance. In addition, energy code and standards objectives now include reducing impact on the electricity grid and increasing building resilience. This paper will explore how and why energy codes can and should account for the health impacts of air pollutants, such as ozone (O3), volatile organic chemicals (VOC), nitrogen oxide (NOx) and particulates (PM2.5).

Energy Code and New York Policy

New York's Climate Leadership and Community Protection Act of 2019 set the goal that the state reduce climate warming emissions at least 85% below 1990 levels by 2050 (CLCPA, 2019). The Climate Action Council Plan of 2022

Jim Edelson is a Senior Climate Advisor at New Buildings Institute (NBI), Portland, Oregon. **Jodi Smits Anderson** is an owner of 2bgreener LLC, Albany, NY. **Grant Sheely** is a Project Manager at NBI, New York, NY. **Tristan Grant** is an Associate Director at NBI, Providence, RI.

called on the state to adopt "highly efficient, and that the state's building sector should adopt building codes for "residential and commercial buildings to be built to a zero-emission and highly efficient standard ……" (CACP, 2022). Thus, the Energy Conservation Construction Code of New York State (ECCCNYS) is widely recognized as the primary policy mechanism to ensure that the new homes and building constructed in New York will contribute to achieving the climate pollution reduction goals specified in the CLCPA. Recognizing the urgency of getting new construction to zero emissions, the Budget Act of 2023 (S4006c) set the adoption timeline for the zero emission codes to be completed between 2025 and 2028.

Direct emissions from New York's buildings account for approximately one-third of the sector's climate emissions and the "current emissions trajectory would result in New York's building sector emitting 69 MMT (Short Tons) CO2e/63 MMT (metric Tons) CO2e in 2050—more than double the economywide emissions allowable under the Climate Act requirements." (NYSERDA, 2022) These findings made it clear that the ECCCNYS would need to drive significant GHG reductions in all the buildings built in the next several decades through two mechanisms: increased energy efficiency and reduction in onsite emissions from combustion equipment (New York State Climate Action Council, 2022). The pollutant targeted by NY policy for the ECCCNYS has primarily been carbon dioxide. Both efficiency and eliminating onsite combustion equipment also reduce emissions of Clean Air Act regulated health-harming pollutants such VOC, NOx, SO2, and PM2.5. Combustion equipment, including gas furnaces and gas water heaters, directly emit significant amounts of these pollutants, while zero-emitting alternatives like electric space and water heaters (whether they use heat pumps or electric resistance heating) do not. As the ECCCNYS is updated this decade to meet the goals of the CLCPA, use of zero emissions equipment to meet the code will vastly increase and will in due course also reduce air pollution impacting residents throughout the state.

It is now widely recognized that various forms of heat pumps will be an attractive route to replace combustion equipment in New York's homes and buildings (Roadmap, 2022). At Climate Week NYC in September 2023, a bipartisan coalition of 24 governors (including Governor Hochul of New York) announced a U.S. Climate Alliance target of installing 20 million heat pumps by 2030 (New York Governors Office, 2023). To advance these building decarbonization efforts, ten member states committed to "explore the adoption of zero-emission standards for space and water heating equipment" (CA, CT, HI, MA, MD, NY, OR, PA, RI, and WA). In February 2024, nine states led by the Northeast States for Coordinated Air Use Management (NESCAUM) signed a memorandum of understanding that builds on the USCA commitment (CA, CO, ME, MA, MD, NJ, NY, OR, and RI) (NESCAUM 2024). The NESCAUM MOU sets a shared goal for heat pumps to make up 65% of residential equipment sales by 2030 and 90% by 2040, and outlines steps the states will take to plan and prepare for policies that will meet this goal. For New York, energy codes will be a critical step to meeting that goal.

This paper will examine how the assertive energy code plan for New York can help achieve these climate goals and result in significant reductions in health burdens and health costs across the state. The Climate Act had dual purposes, both to make significant reductions in climate pollutants and to serve DACs around the state. A strong energy code policy can do both, and the data below show that the health benefits of this policy should be widely recognized in the policy arena.

ENERGY REDUCTION AND ELECTRIFICATION CO-BENEFITS

Importance of Energy Efficiency in Achieving Cost Savings

The work ahead is not only about use of renewably generated electricity. The transition will be more effective for building occupants when we focus first on energy use reductions through efficiency. The current waste of energy in our existing buildings and infrastructure is significant (25-40% waste in heat energy in NY winters) (Hayes, 2022). This is not solely a waste of energy, but also a cause of discomfort, poor health, durability issues such as mold, and lack of affordability. Widely accepted strategies for new and existing buildings can achieve energy use reductions of 70-80% over code minimum compliance levels, helping ensure that operational costs remain low for the life of the building. As codes become more advanced, even using Passive House as a compliance path, we will be driving down energy waste and costs for homeowners and tenants. The most cost-effective investment for existing homes is air sealing and adding insulation (PNNL & ORNL, 2010). In major retrofits of existing buildings that fall under the new construction code, the same priorities and benefits hold.

Reduced energy consumption is also a factor of equipment efficiency and maintenance/ performance. Equipment in a building typically has a shorter life-span than major elements of the building itself, therefore a life-cycle costing lens for new construction makes the building envelope investments the better return on investment (FannieMae, 2019). In a major retrofit to an existing building, this awareness can inform upgrade priorities to HVAC and to the building envelope and structure itself. The final aspect in energy use optimization from improved energy codes is the human factor. When a home has better controlled heating, cooling, and ventilation, all which are provided by properly sized, installed, and maintained equipment, people are more comfortable. This comfort and predictability can lead to acceptance of a broader temperature range, where efficiency of the HVAC systems is further increased as quick corrections are avoided.

Health Benefits of Building End Use Electrification

Electrification has co-benefits for health in the home and in society. In addressing the electricity production at a power plant, we recognize that this production is not fully renewably sourced yet, and it will be some time before it is. However, this production can be "cleaned" with renewable sourcing, and in NYS there is a transition plan for the grid to get to 70% renewable by 2040, and fully renewably sourced by 2050. By reducing fuel burning, including fossil fuels and other feedstocks such as garbage, we dramatically reduce particulate emissions and greenhouse gas emissions. GHG emissions are tied directly to climate changes and the blanketing of the earth, and reducing these has been assigned a cost based on the climate risk created. Particulate emissions and other criteria pollutants are more locationally specific and can burden human health local to the fuel-burning source..Electrification can also reduce energy waste. As we shift to a more distributed system, with district-focused and smaller production sites with battery storage or off-peak management approaches, and more on-site point of use production, we will reduce transmission losses. Transmission losses can be significant, and we are still burdened by the particulate, GHG, and cost burden of that wasted production.

Impacts on Local and Regional Air Quality

When there is a power plant in a community, or near a community, the asthma rates rise significantly due to particulate emissions (NY Department of Health, 2024). The smallest particulates (PM2.5 and below) from any burning of fuel can irreparably damage lung function (International Agency for Research on Cancer, 2016). Waste-to-Energy approaches can result in highly concentrated chemical components as well as PM2.5 and emit equivalent CO_2 while continuing to feed a non-closed cycle material system. Sweden now imports trash from other countries to burn, illustrating that even though the particulate burden stays local, waste-to-energy is not truly a local solution (Kim & Mauborgne, 2019).

Improved Indoor Environmental Quality

Avoiding the use of burned fuel can eliminate these same particulates from living, eating, and sleeping spaces. There is improved safety in direct venting burned fuel appliances, but that safety is limited as often a pilot light is continually burning, or the moment of start-up is unvented. A recent study measured impacts of gas and propane burning in homes and found criteria pollutants remained in the air in the home for several hours after cooking was done, enough to determine that about 19,000 deaths per year in the USA should be attributed to use of gas cooktops in the home (Stanford University, 2024).

Equity at Local Scale

The impacts of climate pollution are universal as we all share complex and far-ranging air systems on our planet. The impacts of particulates and other criteria pollutants are felt at a localized scale. There is an historic and still current lack of representation of Low- to Moderate-Income (LMI) and Black, Indigenous, and People of Color (BIPOC) communities in planning of power production sites, large scale transportation infrastructure, and landfill locations. Criteria Pollutants are dangerous to all while concentrated in underrepresented communities because there is more power production and less investment in upgrading living units in these communities. These DACs also systemically have less access to healthcare, fresh healthy foods, and healthy walkable infrastructure. Poor and underrepresented communities must be not only supported, but disproportionally supported so they can afford to upgrade their own homes to less dangerous heating, cooling, and domestic services and reduce the constant health burden.

EMISSIONS SCENARIO ANALYSIS

This scenario analysis explores the potential impact that an Advanced Energy Code in development and consideration for New York State (NYAEC) would have on criteria pollutant emissions and associated health costs in New York State. It explores the emissions impact at point of combustion on site and at point of generation. DOE prototype building models for Climate Zones 4A, 5A, and 6A for the 2021 IECC were accessed and used for the baseline code (DOE, 2024). These DOE Prototype Building Models are developed by the Pacific Northwest National Laboratory (PNNL) to simulate energy savings associated with changes in energy codes and standards. These energy models aggregate data on annual electricity and natural gas usage. A performance modification factor of 6.5% for residential (single family and < 3 story MF) and 10% (commercial / 4+ MF) was applied to the 2021 IECC models to account for the performance improvements of IECC 2024 (IECC, 2024). Proposed models were developed for the NYAEC in context of the Zero Emission New Construction legislation for New York State (S4006c) (Urban Green Council, 2023). The NYAEC was intended to achieve net-zero ready levels of energy performance, and no gas usage was included in the proposed code prototype models. The analysis looked at single family, low-rise multifamily (3 stories and below), and mid/high-rise multifamily (4+ stories) prototype building models. The baseline prototype building models were modified by a team at PNNL to estimate the savings in the NYAEC. New Construction Data was accessed from Dodge Data and Analytics and used to identify the new construction square footage by building type for the years 2014-2022, and to identify the average new construction by building type (DCN, 2024). The energy model results for baseline and proposed models for the building typologies built to the baseline and to the proposed codes were combined into a weighted energy intensity (kBTU/SF or J/m2) value by fuel source for the three climate zones, and then a weighted average energy intensity value by fuel source for the entire state. The weighted average energy intensity was multiplied by the total new construction square footage associated with the studied building types to determine the gross annual on-site fuel usage and electricity usage associated with the baseline and proposed energy codes. The gross electricity usage was multiplied by 1.077 to account for grid transmission and distribution losses to determine gross electricity generation associated with the baseline and proposed energy codes (Hammer, et.al. 2022). Year 1 baseline code results are found in Table 1 and year 1 proposed code results are found in Table 2.

Table 1 Year 1 Baseline Code Energy Usage by Building Type and Fuel Type

Building Type	New Construction (Square Feet/Meters Squared)	Electricity Usage (kBTU/kJ)	Natural Gas usage (kBTU/kJ)	Oil Usage (kBTU/kJ)
Single Family	20,714,778 / 1,924,465	433,481,060 / 457,346,793	410,018,603 / 432,592,587	22,930,793 / 24,193,270
MF < 3 Stories	7,399,889/ 687,472	156,917,819 / 165,557,086	118,615,063 / 125,145,534	-
MF > 4 Stories	36,425,222 / 3,384,012	1,054,803,297 / 1,112,876,547	179,881,767 / 189,785,338	-

Table 2 Year 1 Proposed Code Energy usage by Building type and Fuel Type

Building Type	New Construction Square Feet/ Meters Squared)	Electricity Usage (kBTU/kJ)	Natural Gas usage (kBTU/kJ)	Oil Usage (kBTU/kJ)
Single Family	20,714,778 / 1,924,465	485,497,491/ 512,227,041	-	-
MF < 3 Stories	7,399,889/ 687,472	204,932,877/ 216,215,661	-	-
MF > 4 Stories	36,425,222/ 3,384,012	970,139,039/ 1,023,551,014	-	-

Using the statewide (kBTU/SF)/(kJ/m2) data for the projected new construction rates, emissions profiles were estimated for the baseline and proposed energy codes. These profiles include emissions from on-site combustion and emissions from electricity generation. The following analyses looked only at the impact of Year-1 New Construction square footage and did not estimate or project the impact of all future new construction built under the baseline and proposed/stretch codes. Due to this it is only a partial calculation of the emissions and ensuing health cost impacts associated with the codes and does not account for the continued impact of each year of new construction square footage built under the proposed code.

Electricity Generation Emissions

Criteria pollutant emissions data for electricity generation for New York State for the years 2025-2050 was taken from the Mid-Case 95% CO_2 reduction for 2050 scenario presented in a 2023 NREL study (Gagnon, Hale, & Cole, 2023). The baseline and proposed gross electricity generation was multiplied by the Mid-Case emissions factors to identify gross annual grid emissions associated with the two codes for VOC, PM2.5, NOX, SO2. Gross annual grid emissions were calculated for year one of code implementation (2025) and for future study years to understand how the proposed code would impact electricity generation emissions associated with new construction as New York hits key climate milestones when compared to the base code. The annual electricity savings for all building types was combined to determine the total annual electricity savings, and the associated annual grid emissions reduction. The study years were 2025 (Year 1), 2030, 2040, and 2050. These results can be found in Table 3. Criteria emissions increased because of the transfer of gas loads to electricity while at the same time, the grid gets cleaner. The results reflect the balance of these two effects over time. The gross annual emissions reduction of the proposed code when compared to the baseline informed the calculation of associated health costs profiles and the following health cost impact analysis.

Table 3 Study Year Grid Associated Criteria Emissions Increases of Proposed Code over Base Code

Study Year	VOC Increase (Short tons/Metric Tons)	NOx Increase (Short tons/Metric Tons)	SO2 Increase (Short tons/Metric Tons)	PM2.5 Increase (Short tons/Metric Tons)
2025	0.09/0.08	0.61/0.55	0.19/0.17	0.13/0.12
2030	0.08/0.07	0.48/0.44	0.16/0.15	0.10/0.09
2040	0.02/0.02	0.11/0.10	0.03/0.03	0.02/0.02
2050	0.01/0.01	0.10/0.09	0.02/0.02	0.02/0.02

On-site Combustion Emissions

Data for emissions by fuel source for on-site combustion equipment was taken from the EPA 2020 National Emissions Inventory (Office of Air Quality Planning and Standards, 2020). This data was used together with the energy use intensity by fuel source information to identify criteria emissions associated with on-site fuel use in the baseline and proposed energy codes. There were zero emissions associated with the proposed code and so the reduction was 100%. On-site fuel-use emissions reductions of proposed code over base code can be found inTable 4. On-site emissions were assumed to be steady throughout the life of the buildings and for each of the study years were equal to the Year-1 emissions estimates.

Table 4 Annual On-Site Fuel Emission Reduction of Proposed Code over Base Code

	VOCs (Short tons/Metric Tons)	NOx (Short tons/Metric Tons)	SO2 (Short tons/Metric Tons)	PM2.5 (Short tons/Metric Tons)
Statewide Total	19.05/17.28	326.06/295.80	2.09/1.90	26.27/23.83

Emissions and Health Cost Impacts

This study presents a quantitative analysis of the health impacts of an advanced energy code in context of a zero emissions new construction policy using the NYAEC and 2024 IECC national model code as points of comparison. This study used a methodology presented in a 2015 ACEEE white paper to evaluate the emissions benefits potential (ACEEE, 2015). EPAs Co-Benefits Risk Assessment Health Impact Screening and Mapping Tool (COBRA) tool was used to quantify and compare healthcare costs (EPA, 2024). The study authors used the criteria pollutant emissions associated with electricity generation and on-site combustion for the baseline and proposed codes in the COBRA tool to identify potential health cost impacts resulting from the implementation of the proposed code. On-site emissions reductions were assumed to be stable and equivalent to Year-1 reductions throughout the study years. Annual on-site emissions health cost reductions of the proposed code can be found in Table 5. Annual electricity generation emissions health cost impacts of the proposed code can be found in Table 6. Both these health cost estimates account for only one year of new construction square footage (“Year 1”, or 2025), and only account for health impacts in New York state. The values should be understood as an estimate of the health cost savings that could be realized with each year of new construction square footage built under the proposed code when compared to the base code. The scale of these values can be understood when compared to the scale of the criteria emissions results shown in Table 3 and Table 4.

Table 5 Proposed Code - Annual On-Site Combustion Emissions Health Cost Reduction

Study Year	PM Impacts – Low End	PM Health Impacts – High End	O3 Health Impacts – Low End	O3 Health Impacts – High End	Total Health Impacts – Low End	Total Health Impacts – High End
2025-2050	$25,000,000	$53,000,000	$5,700,000	$5,700,000	$31,000,000	$59,000,000

Table 6 Proposed Code - Annual Electricity Generation Emissions Health Cost Increase

Study Year	PM Impacts – Low End	PM Health Impacts – High End	O3 Health Impacts – Low End	O3 Health Impacts – High End	Total Health Impacts – Low End	Total Health Impacts – High End
2025	$(44,000)	$(89,000)	$(13,000)	$(13,000)	$(57,000)	$(100,000)
2030	$(32,000)	$(67,000)	$(9,100)	$(9,100)	$(41,000)	$(76,000)
2040	$(6,400)	$(3,000)	$(2,100)	$(2,100)	$(8,500)	$(16,000)
2050	$(6,100)	$(13,000)	$(1,900)	$(1,900)	$(8,000)	$(15,000)

The cumulative avoided health costs of grid and on-site emissions can be seen in Figure 1. This illustrates that increases in grid generation emissions associated health costs are dwarfed by those from on-site emissions associated health costs. Energy cost savings were estimated using the DOE cost effectiveness methodology for the baseline model code and the proposed NYAEC code. The magnitude of the health costs savings in relation to the energy cost savings demonstrates the significance of criteria emissions reductions relative to efficient use of energy in code development. The full electrification associated with the proposed code saw a minor increase in total electricity usage and therefore saw a minor increase in grid-associated emissions and grid-emissions-associated health costs. These results do show a small but measurable shift of onsite emissions to grid-associated emissions and these should be a component of future research and analysis.

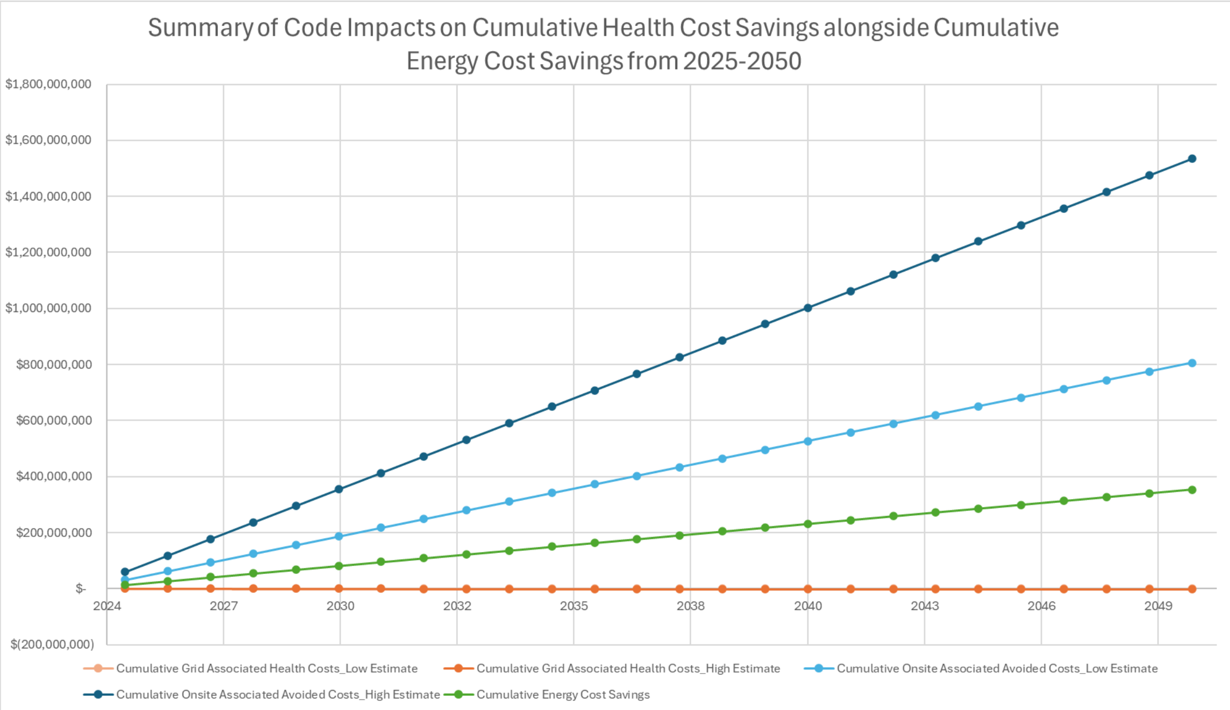

Figure 1. The Cumulative Health Cost Impact of One Year of NY construction activity: Grid Associated Health Costs and Onsite Associated health cost alongside the Cumulative Energy Cost Savings from 2025 to 2050.

IMPACTS ON DISADVANTAGED COMMUNITIES (DACS)

In evaluating the burden on DACs, the authors relied on New York's use of 45 criteria in determining qualifying communities: land use and facilities with historic discrimination, potential climate change risks, potential pollution exposures, income levels, race and ethnicity, health outcomes and sensitivities, and housing mobility and communications (New York Climate Action Council, Accessed 2024). Using this matrixed and complex overview of state residents, NYS determined 35% of the state is in a DAC at a level of concern deserving attention through Climate Action policies.

Building Density and Local Site Combustion Pollutants

Building density has an impact on GHG and particulate emissions. Logically, the climate pollution burden per capita in a densely populated city is lower, due to increased walkability, use of transit, and smaller living units. Even so, the living density, the higher urban heat island impacts, the vehicle congestion, and the massive need to ship goods in and out of the denser cities all leads to a concentration of GHG and particulate emissions, and PM2.5 levels tend to stay close to location of combustion. This all puts a greater health burden on medium and large city residents, focused on respiratory health burdens. The mapping of NY state DACs supports this, illustrating asthma and related hospital visits as higher in areas of population density and alongside large traffic conduits such as I-87 (north-south) and I 90 (east-west). Much of this is aligned with power plant locations, but adding to the concentration would be any fuel-burning mechanical systems, gas-fired stoves and water heaters, and even large-scale gas-fired co-gen systems. This study's findings demonstrate that the health benefits of zero emissions codes directly benefit DACs through the reduction of on-site emissions in densely populated cities.

DACs, Proximity of Electricity Generation, and Indoor Air Quality

Large cities also tend to have more energy plants within 1 mile of poorer communities, as shared above, and more significant PM2.5 emissions throughout. PM2.5 are part of the matrix in determining DACs as is proximity to fossil fuel burning power plants. In reviewing data and mapping imagery from NY state efforts under the NYS Climate Law, the alignment of these two data points is clear. Note that PM2.5 does spread much wider than the 1-mile proximity to power plant locations and can be impacted by prevailing winds. Asthma rates and resultant hospital visits can be another indicator of particulate health burdens. In NY state, the concentrations are heavy in historically redlined communities in denser urban centers, although asthma is also of significant concern at the unpopulated northern expanse above Saranac Lake. This northern area increase in asthma may be due to power generation outside of NY state, other asthmatics such as large-scale farming practices, or less commonly available healthcare meaning situations move to emergency level rather than prevention. This study demonstrates that the elimination of on-site combustion in New York did not result in shifting of significant health costs to communities in proximity to central electricity generation plants.

Indoor Air Pollutants

The ECCCNYS calls for building airtightness along with properly sized ventilation systems, with any fuel-burning HVAC systems outside of that barrier, in a weather-sealed equipment room, or directly vented. Ventilation is at most controlled through using CO2 as a proxy for quality and only through still uncommon air quality testing services can we measure impactful toxins and contaminants such as PM2.5, and VOCs. Though the codes have improved, we have homes and dwelling units at all scales with inadequate ventilation. Based on the research of National Institute of Environmental Health Services (NIEHS), the four factors for good indoor air quality are: 1) Minimize emissions, 2) Keep it dry, 3) Ventilate well and, 4) Protect against outdoor pollution. Potentially the worst case for human health within a home occurs in buildings that are tight and energy efficient with fuel-burning systems and appliances within that tight envelope, and that may have insufficient ventilation or that are not using ventilation systems properly (Adamkiewicz, et al., 2011). Although this study did not evaluate or include the health cost impacts of indoor air pollutants there is a large body of evidence that elimination of on-site combustion for cooking appliances results in occupant health benefits. Further analysis could evaluate the additional health impacts associated with indoor air pollutants.

RECOMMENDATIONS

Based on the findings of this paper, the authors recommend that jurisdictions adopting contemporary energy codes to reduce climate pollution also seek to understand the health costs tied to criteria pollutants from fuel-burning equipment. Understanding the significant health cost reductions available through codes can better inform code development decisions, including an electrification trend to reduce combustion within buildings over time. AHJ's can now access data to include Health Cost of criteria pollutants along with the Societal Cost of Carbon in energy code cost-effectiveness calculations. Though dispersed data is currently available, code development agencies should work more closely with air quality agencies at state and regional levels to target this data. In addition, we recommend the standardization of energy code health impact analysis be developed through these agencies, perhaps led by the U.S. Environmental Protection Agency (EPA). Better data and analysis will inform the correct pace of transition of the built environment away from fuel-burning equipment in homes and buildings. In addition, the model energy code development processes at both the International Code Council (ICC) and ASHRAE should no longer exclude health impacts from their internal cost analyses. Only these changes at all levels of code development will ensure all buildings are healthy for the people who use and live in them. In terms of cost-effectiveness tests, the New York legislature in the Advanced Energy Codes Act of 2022 recognized the importance of climate and health impacts, and mandated that the state "shall consider... secondary or societal effects" in evaluating the cost-effectiveness of its energy codes. This is an important precedent to apply at the model code level and through local adoptions.

CONCLUSION

It is a foregone conclusion that health and safety are primary objectives of governing jurisdictions and for the codes that they adopt. In one way or another, each energy code scope section says "any safety, health or environmental requirements" should not be circumvented. But energy codes themselves had never traditionally been designed to improve human health. We have demonstrated that human health impacts can be directly addressed by the energy code. And we have shown that, in monetized terms, the health savings can dramatically exceed the energy cost savings when codes address onsite combustion in New York's homes and buildings. It is now essential that these significant health impacts, and available cost savings, are considered in model code development, and in state and local adoptions across the country.

REFERENCES

ACEEE. (2015, March). Navigating the Clean Power Plan: A Template for Including Envery Codes in State Compliance Plans. Retrieved from 123 Solutions for States: Energy, Economy & Environment: https://www.aceee.org/sites/default/files/111d-building-codes-template-0315.pdf

Adamkiewicz, G., Zota, A. R., Fabian, M. P., Chahine, T., Julien, R., & Spengler, J. D. (2011). Moving environmental justice indoors: understanding structural influences on residential exposure patterns in low-income communities. American Journal of Public Health.

DCN. (2024, February 02). Dodge Construction Network. Retrieved from https://www.construction.com/

DOE. (2024). Prototype Building Models. Retrieved from Building Energy Codes Program: https://www.energycodes.gov/prototype-building-models

EPA. (2024, August). CO-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA). Retrieved from epa.gov: https://www.epa.gov/cobra

EPA Energy Star . (2015, August). Thermal Energy Conversions Technical Reference.

FannieMae. (2019). Appendix F - Estimated Useful Life Tables. Instructions for Performing a Multifamily Property Assessment (Version 2.0). Fannie Mae.

Hammer, H., Heavey, C., Felicien, H., & Patel, K. (2022). Projected Emissions Factors for New York State Grid Electricity. New York : NYSERDA.

Hammer, H., Heavey, C., Felicien, H., & Patel, K. (2022). Projected Emissions Factors for New York State Grid Electricity. Albany: New York State Energy Research and Development Authority.

Hayes, Z. (2022, March 11). Airtightness in buildings: Don’t let it slip through the cracks! Retrieved from RMI: https://rmi.org/airtightness-buildings-dont-let-slip-cracks

IECC. (2024). The International Code Council Board of Directors Makes Final Decision on 2024 IECC Appeals and Addresses Preemption Challenges . Retrieved from ICC Pulse: https://www.iccsafe.org/about/periodicals-and-newsroom/icc-pulse/the-international-code-council-board-of-directors-makes-final-decision-on-2024-iecc-appeals-and-addresses-preemption-challenges/#:~:text=The%20Board%27s%20determinations%20mark%20the,by%2010

International Agency for Research on Cancer. (2016). Outdoor Air Pollution - Volume 109. Lyon, France: WHO.

Kim, C., & Mauborgne, R. (2019, August 27). Turning Waste to Energy: Sweden’s Recycling Revolution. Retrieved from Blue Ocean Strategy Blog: https://www.blueoceanstrategy.com/blog/turning-waste-energy-sweden-recycling-revolution/#:~:text=Turning%20trash%20into%20energy%3A%20Sweden's%20recycling%20strategy&text=The%20United%20Kingdom%2C%20Norway%2C%20Ireland,to%20over%201%20million%20households

New York Climate Action Council. (Accessed 2024). Disadvantaged Communities Criteria. Retrieved from New York Climate Act: https://climate.ny.gov/resources/disadvantaged-communities-criteria/

New York Governors Office. (2023, September 21). Governor Hochul Joins U.S. Climate Alliance Governors to Accelerate Building Decarbonization. Retrieved from NY Governor: https://www.governor.ny.gov/news/governor-hochul-joins-us-climate-alliance-governors-accelerate-building-decarbonization#:~:text=As%20part%20of%20the%20Alliance%E2%80%99s%20new%20heat%20pump,40%20percent%20of%20benefits%20flow%20to%20disadvantaged%20commu

New York State Climate Action Council. (2022). New York State Climate Action Council Scoping Plan. climate.ny.gov/scopingplan.

NY Department of Health. (2024, March). Outdoor Air and Health. Retrieved from Particle Pollution and Health: https://www.health.ny.gov/environmental/indoors/air/pmq_a#:~:text=Particle%20pollution%20from%20fine%20particulates,the%20air%20to%20appear%20hazy.

NYSERDA. (2022). New York's Carbon neutral Buildings Roadmap. Albany: NYSERDA.

Office of Air Quality Planning and Standards. (2020). 2020 Nationall Emissions Inventory. Durham: U.S. Environmental Protection Agency.

PNNL & ORNL. (2010). Retrofit Techniques & Technolkogies: Air Sealing - A Guide for Contractors to Share with Homeowners. DOE EERE.

Stanford University. (2024, May 3). Quantifying U.S. health impacts from gas stoves. Retrieved from Science Daily: https://www.sciencedaily.com/releases/2024/05/240503172624.htm#:~:text=Even%20in%20bedrooms%20far%20from,pollution%20in%20U.S.%20homes%20found.

Urban Green Council. (2023, May 3). Decoding New York State's all-electric new buildings law. Retrieved from https://www.urbangreencouncil.org/decoding-new-york-states-all-electric-new-buildings-law/