Data-Driven Environmental Policy in Times of Economic Turmoil: PlaNYC's Successful Initiative to Clean Up the Heating Oil Sector

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Abstract: After the adoption of PlaNYC in April 2007, New York City was able to change city and state laws to clean up the heating oil sector, despite significant economic uncertainty during Great Recession that occurred from late 2007 to mid-2009.[1] The success of what became known as the Clean Heat campaign was enabled by a data-driven analysis of health benefits and economic costs undertaken by academics, agencies, and environmental groups, which informed extensive stakeholder engagement in the legislative and regulatory arenas and was facilitated by the Bloomberg Administration's measure-then-management governing philosophy.[2] The foundation for the initiative was prepared by the New York City Community Air Survey (NYCCAS) that combined ground-level air quality data, refined local source emissions estimates, and maps that illustrated the small number of sources that emitted a great amount of pollution that affected many people. According to the data, 1% of buildings in the city generated over 80% of building-related PM2.5 emissions, impacting air quality in both poor and rich neighborhoods. This article tells the story of how a public health and environmental justice approach to air quality regulation allowed for the conception and implementation of NYCCAS, while at the same time a robust stakeholder engagement process and sensitivity to the economics of fuel switching allowed for clean air regulations that were accepted by building owners, oil companies, and other affected entities. The article also illustrates how PlaNYC reshaped local government to work across departmental silos and with

[1] "US Business Cycle Expansions and Contractions", United States NBER, or National Bureau of Economic Research, updated March 14, 2023. This government agency dates the Great Recession as starting in December 2007 and bottoming-out in June 2009.

[2] For example, as one of the first sustainability plans of any city, PlaNYC undertook a careful "wedge" analysis of possible carbon reduction measures before adopting its goal of a 30% reduction of greenhouse gases by 2030. Later city and state measures adopted higher reduction goals and longer timeframes (e.g., 40% by 2030 and 85% by 2050 in the New York Climate Leadership and Community Protection Act of 2019) based in part on what were deemed science-based targets to galvanize public and private action, rather than a plan of tangible measure. In that sense PlaNYC's target was a "bottom up" strategy while later targets were "top down" mandates.

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outside environmental organizations, businesses, and research institutes to understand concerns, amass and communicate data in a compelling way, and generate solutions.

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Introduction

In the early 2000s, thousands of apartment complexes, shopping centers, and schools across New York City were still heating their air and water like they had in the last century. In basements and utility rooms in some of the city's largest buildings—especially in Manhattan—boilers burned one of the dirtiest petroleum products available. Heating oil is classified as Number 2, 4, or 6 (Nos. 2, 4, 6) based on composition, boiling point, and viscosity. No. 6 heating oil is the leftover residue after higher grades of petroleum products are distilled out; the residue is so viscous that it is near solid at room temperature and black like tar. Yet this tar-like fuel could also be delivered cheaply by truck to the City's densely-packed buildings, and so rather than use cleaner heating options like natural gas or No. 2 "distillate" oil, nearly 10,000 buildings continued to rely on cheaper No. 4 and No. 6 "residual" oil.[3] Other than large apartment, commercial, and institutional buildings in New York City, No. 6 oil was principally used as "bunker" fuel in cargo ships on the high seas, away from population centers, and in some industrial and electricity generating plants.[4]

Combusting residual oil emits especially high amounts of fine particulate matter ($PM_{2.5}$): particles comprised of a mix of chemicals. These particles are so small they can travel deep into lungs and even slip into the bloodstream, impairing respiratory and cardiovascular function and contributing to premature mortality. The $PM_{2.5}$ emitted by residual oil has especially elevated concentrations of certain metals like nickel and vanadium that help identify their source. In the early 2000s, heating oil was responsible for about 29% of the $PM_{2.5}$ emissions generated locally within the City;[5] in some Manhattan zip codes, residual oil may have contributed the majority of harmful soot and airborne nickel.[6] And while only about 1% of all New York City buildings burned residual oil,[7] they included some of the City's most visible institutions, including nearly 500 public schools and the central heating plant and prominent buildings on Columbia University's campus.

PlaNYC set a goal for New York City to achieve the cleanest air quality of any major U.S. city by 2030.[8] This was ambitious given that the influential American Lung Association State of the Air 2007 report noted that out of 25 major metropolitan areas, NYC ranked 16th in number people at risk of short term particle pollution (PM2.5), 17th for year round PM2.5, and 10th for ozone.[9] Moreover, many of the causes of poor air quality such as interstate air pollution from upwind

[3] EDF, Bottom of the Barrel, https://www.nyc.gov/html/om/pdf/2009/pr_538_nyccas_report.pdf.

[4] Institute for Policy Integrity, Residual Risks: The Unseen Costs of Using Dirty Heating Oil in New York City Boilers (January 2010), https://policyintegrity.org/files/publications/ResidualRisks.pdf.

[5] PlaNYC 2007, https://www.nyc.gov/html/planyc/downloads/pdf/publications/full_report_2007.pdf.

[6] EDF.

[7] NYC Council Committee on Environmental Protection, Committee Report of July 28, 2010.

[8] City of New York. (2007). *PlaNYC: A greener, greater new york*. Office of the Mayor. https://www.nyc.gov/assets/climate/downloads/pdfs/PlaNYC-full_report_2007.pdf

[9] American Lung Association, *State of the Air: 2007*, Washington, D.C. (available via the Kentucky Public Service Commission reference archive).

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coal plants and engine standards were the primary, if not exclusive, province of the federal government. Accordingly, PlaNYC focused on local sources that could be reduced by City policies—reducing road vehicle emissions through local fleet improvements and standards, enforcing anti-idling rules, reducing emission from ferries and construction vehicles, and reducing emissions from buildings.

By 2009, the Mayor's office was ready to develop a policy to clean up the City's heating fuels.[10] Building owners, schools, and other stakeholders cautioned how costly switching their boilers from oil to gas might be, especially at a time when City coffers, business owners, and the many New Yorkers renting in large apartment complexes were still struggling to recover from the Great Rescission. Yet just a few short years later, the City was well on its way to phasing out residual oil and substantially improving local air quality, with some measures of air pollution decreasing 69% within just five years.[11]

A key to this remarkable turnaround was the confluence of several data-driven initiatives. The City's Department of Health and Mental Hygiene (DOHMH) created the New York City Community Air Survey (NYCCAS) that identified sources that were outsized emitters of air pollutants. Meanwhile, environmental advocates connected the dots between buildings with permits to burn No. 4 or 6 oil and the City's air pollution hot spots, an analysis that drove media attention and public interest in the narrative. Finally, academic researchers developed a new methodology to trace high-nickel $PM_{2.5}$ emissions back to their source in buildings' boilers, and to quantify the hundreds of lives per year that could be saved by switching those boilers to a cleaner fuel. This data helped move stakeholders away from all-or-nothing policy proposals and instead toward a compromise regulatory solution.

This article explains the development of what became known as the Clean Heat Initiative and explores how PlaNYC encouraged data-driven policies, cross-agency cooperation, and a pragmatic and even incremental approach to achieving feasible wins using a nuanced benefit-cost analysis. These foundations of success may provide a model for environmental policy today when affordability concerns are once again causing many people to consider the modification of climate commitments.

Focusing on the Problem of Heating Oil Pollution

New Yorkers knew that large local buildings and their boilers emitted a lot of pollution. Smoke from these buildings were the frequent subject of citizen complaints through the City's 311

[10] 2009 Progress Report.

[11] NYCCAS data were also used to evaluate retrospectively the effectiveness of clean heat and related measures. A 69% reduction in ambient SO2 levels between the winter of 2008-9 and 2012-13 was announced by Mayor Bloomberg, who described the city's air as the "cleanest in 50 years." Taylor, Kate. 2013. "New York's Air Is Cleanest in 50 Years, Survey Finds." New York. The New York Times, September 27. https://www.nytimes.com/2013/09/27/nyregion/new-yorks-air-is-cleanest-in-50-years-survey-finds.html.

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system.[12] Unsurprisingly then, the 2007 PlaNYC had a dedicated chapter on air quality that identified heating fuel as the source of the largest share of the locally-emitted $PM_{2.5}$ that, if addressed, could help the City achieve its ambitious goal of the "cleanest air quality of any big U.S. city."[13] Much of the City's air pollution actually drifted in from upwind, non-local sources, but 45% of ambient $PM_{2.5}$ in New York City came from local sources, and 29% of that pollution came from heating fuels.[14] The City has broad power to regulate activities for the welfare of residents and the environment unless preempted by state or federal law, and had already previously exercised this power to ban dirty solid fuels, including banning the burning of bituminous high sulfur coal and banning the use of residential incinerators following toxic smog events in the 1960s.[15]

Though PlaNYC immediately identified residual oil as a major problem, the first set of initiatives in 2007 did not yet target phasing out residual oil citywide as a solution. Instead, PlaNYC's initiatives initially focused on lowering the sulfur content of No. 2 distillate heating oil and funding city schools to switch their boilers off Nos. 4 and 6 oil to cleaner options.[16] But by 2009, the City recognized that funding boiler conversions one at a time at city schools and hospitals through the slow public procurement process would be insufficient to make enough of a dent in the City's air pollution. The April 2009 PlaNYC Progress Report announced "a policy to phase out residual heating oil use by 2030."[17]

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[12] Testimony of Caswell F. Holloway, Commissioner, New York City Department of Environmental Protection (DEP), New York City Council Committee on Environmental Protection hearing on Intro 194—The Use of Clean Heating Oil in New York City, May 28, 2010.

[13] City of New York Office of the Mayor. 2007. PlaNYC: A Greener, Greater New York. PlaNYC. City of New York. https://climate.cityofnewyork.us/wp-content/uploads/2022/10/PlaNYC-full_report_2007.pdf.

[14] US EPA, OAR. 2016. "Reviewing National Ambient Air Quality Standards (NAAQS): Scientific and Technical Information." Collections and Lists. September 9. https://www.epa.gov/naaqs.

[15] A toxic smog over the Thanksgiving weekend in 1966 is estimated to have killed 168 people from dangerous levels of carbon monoxide, sulfur dioxide, PM2.5, PM10, and other pollutants. Popkin, Roy (1986). "Two 'Killer Smogs' the Headlines Missed" (PDF). EPA Journal. 12 (10). EPA: 27–29. Archived (PDF) from the original on May 18, 2017 – via EPA.gov; New York City Council Committee on Environmental Protection Intro 194, Testimony of Caswell F. Holloway, Commissioner, New York City Department of Environmental Protection (May 28, 2010). Following similar events in 1953 and 1963 (and even earlier incidents that were documented in a 1937 article on the significant emissions from heating homes and other buildings with coal) the public had enough and the City created the modern NYC Air Code that directly regulated the sulfur content of coal and other fuels. Other large cities banned solid heating fuels before the creation of the federal Clean Air Act Amendments of 1970, which recognized the need for regional and national actions to address ozone and later PM2.5 from upwind sources. Bachmann, J. (2007). Will the Circle Be Unbroken: A History of the U.S. National Ambient Air Quality Standards. Journal of the Air & Waste Management Association, 57(6), 652–697. https://doi.org/10.3155/1047-3289.57.6.652.

[16] PlaNYC 2007; *see also* 2008 Progress Report, https://www.nyc.gov/assets/climate/downloads/pdfs/planyc_progress_report_2008.pdf.

[17] https://www.nyc.gov/html/planyc/downloads/pdf/publications/planyc_progress_report_2009.pdf. See also https://www.nyc.gov/assets/climate/downloads/pdfs/iclei_planyc_case_study_201004.pdf on timeline.

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Yet key questions remained regarding feasibility, costs, and implementation. A report from the Energy Policy Research Foundation making the rounds in early 2009 warned that "direct costs of banning No. 4 and No. 6 fuels . . . could easily exceed $280 million per year," with dire predictions of renters' heating costs doubling and job losses rippling through the City.[18] Though such cost predictions proved to be exaggerated and may have overlooked some more cost-effective conversion options,[19] the cost concerns of building owners, tenants associations, and other stakeholders were valid and could not be dismissed, especially given the historically unpredictable supply and higher cost of cleaner substitutes like natural gas and No. 2 oil. The onus was on local government experts, environmental advocates, and other researchers to convince elected officials and otherpolicymakers that the benefits of phasing out residual oil would justify any costs and that there was a pragmatic path to compliance.

The distribution of the burdens--both of pollution and the costs of cleaning it up--was another important dimension. PlaNYC noted that air quality improvements "were not shared equally" among the City's communities. While prior studies had identified local "hot spots" associated with traffic pollution within disadvantaged neighborhoods like Harlem[20] and the South Bronx,[21] the regulatory monitoring and emissions inventory data available at the time were not well suited to systematically assess year-round, city-wide spatial variation in pollutant concentrations and important associated sources. Environmental justice communities and New York City Sustainability Advisory Board members expressed concern about the inadequacy of regulatory monitoring during over two dozen meetings during the development of PlaNYC.[22]

In short, more research was needed on which buildings were responsible for emitting $PM_{2.5}$, which neighborhoods suffered as a result, and what the ultimate health effects were.

NYCCAS Data on Heating Oil Pollution

The need for more sophisticated and fine-grained air monitoring data throughout New York City was well known.[23] For example, during PlaNYC stakeholder discussions, the leader of WE-ACT for Environmental Justice recalled how some of the best available data came from studies with

[18] EPR Inc., Costs and Supply Risks to Prohibitions On the Use of No. 4 and No. 6 Oil in New York City (Feb. 2009).

[19] *See* EDF.

[20] Kinney, P. L., M. Aggarwal, M. E. Northridge, N. A. Janssen, and P. Shepard. 2000. "Airborne Concentrations of PM(2.5) and Diesel Exhaust Particles on Harlem Sidewalks: A Community-Based Pilot Study." Environmental Health Perspectives 108 (3): 213–18.

[21] Maciejczyk, Polina B., John H. Offenberg, Jessica Clemente, Martin Blaustein, George D. Thurston, and Lung Chi Chen. 2004. "Ambient Pollutant Concentrations Measured by a Mobile Laboratory in South Bronx, NY." Atmospheric Environment 38 (31): 5283–94. https://doi.org/10.1016/j.atmosenv.2004.02.062.

[22] Personal communication with Ariella Maron, first Deputy Director of the Office of Long-Term Planning and Sustainability, with Carter Strickland on March 20, 2026.

[23] After the Thanksgiving weekend smog of 1966, one of New York City's first steps was to create a network of 38 air quality monitoring stations that were installed in 1968. Bird, David (November 1, 1968). "City Begins Monitoring 3 Kinds of Air Pollutants". The New York Times.

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local college and high school students wearing backpacks with portable air quality monitors inside, to measure personal exposure to air pollutants.[24] While such studies were designed to measure traffic-related pollution, there were also high readings away from highways and near large apartment buildings. In other words, in addition to revealing pollutant exposures that were not being picked up by the existing monitoring stations installed by the federal EPA or New York State Department of Environmental Conservation (DEC) NAAQS stations,[25] such backpack studies and other community-based monitoring effort were already identifying large apartment buildings as a key source of air pollution. More data was clearly needed.

As a result of these efforts, one of the pillars of PlaNYC was launching a "collaborative local air quality study," which ultimately became the New York City Community Air Survey (NYCCAS).[26] NYCCAS provided valuable information on spatial patterns of air pollution across the city. NYCCAS data helped characterize variation in pollutants,[27] including components associated with residual oil combustion such as nickel,[28] and contributed to a more detailed understanding of how air pollution levels differed across neighborhoods. These data were used to inform technical analyses, support public communication, and contribute to discussions during policy development and legislative processes. The data and associated pollution maps, replicated below, was also widely disseminated in contemporaneous public reporting, which helped raise the visibility of building-related air pollution in New York City and its connection to heating fuel use.[29]

[24] Breckwich Vasquez, Victoria, Minkler, Meredith, and Shepard, Peggy, Promoting Environmental Health Policy Through Community Based Participatory Research: A Case Study from Harlem, New York, (Feb. 2006), Journal of urban health : bulletin of the New York Academy of Medicine, 83(1):101-10, doi:10.1007/s11524-005-9010-9. For more about the partnership between local residents, DOHMH, and Columbia University, see https://www.publichealth.columbia.edu/news/school-city#:~:text=Wearing%20backpack%20air%20monitors%20and%20carrying%20digital%20counters%2C%2017%20teenagers%20scattered%20throughout%20Harlem.

[25] Mananga ES, Lopez E, Diop A, Dongomale PJ, Diane F. The impact of the air pollution on health in New York City. J Public Health Res. 2023 Nov 29;12(4):22799036231205870. doi: 10.1177/22799036231205870. PMID: 38034845; PMCID: PMC10687960.

[26] "NYC Community Air Survey - NYC Health." n.d. Accessed March 27, 2026. https://www.nyc.gov/site/doh/data/data-sets/air-quality-nyc-community-air-survey.page.

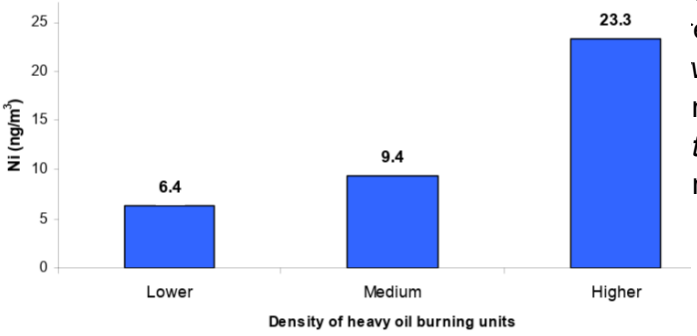
[27] Clougherty, Jane E., et al. "The New York City Community Air Survey: Results from Winter Monitoring 2008–2009." *New York City Department of Health and Mental Hygiene, and NYC Mayor's Office for Long-Term Planning and Sustainability http://www.nyc.gov/html/doh/downloads/pdf/eode/nyccas_master_report_12_15_09.pdf* (2009).

[28] Clougherty Je, K. I., et al. "The New York City Community Air Survey Supplemental Report: Nickel Concentrations in Ambient Fine Particles: Winter Monitoring, 2008–2009." *New York City Department of Health and Mental Hygiene, and NYC Mayor's Office for Long-Term Planning and Sustainability: New York, NY, USA* (2010).

[29] Revkin, A. C. (2010, January 1). *City air is cleaner, but still not clean enough*. The New York Times. https://www.nytimes.com/2010/01/01/science/earth/01pollute.html

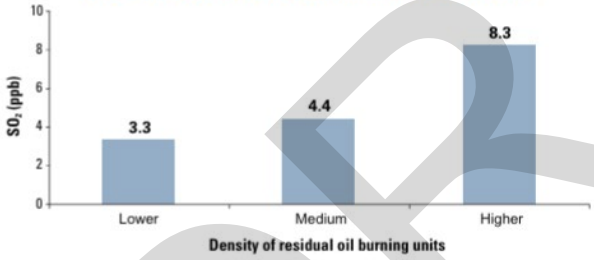
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Figure Ni-1: Ni levels in areas with high density of heavy oil burning units are nearly 4 times those of those in areas with the low density



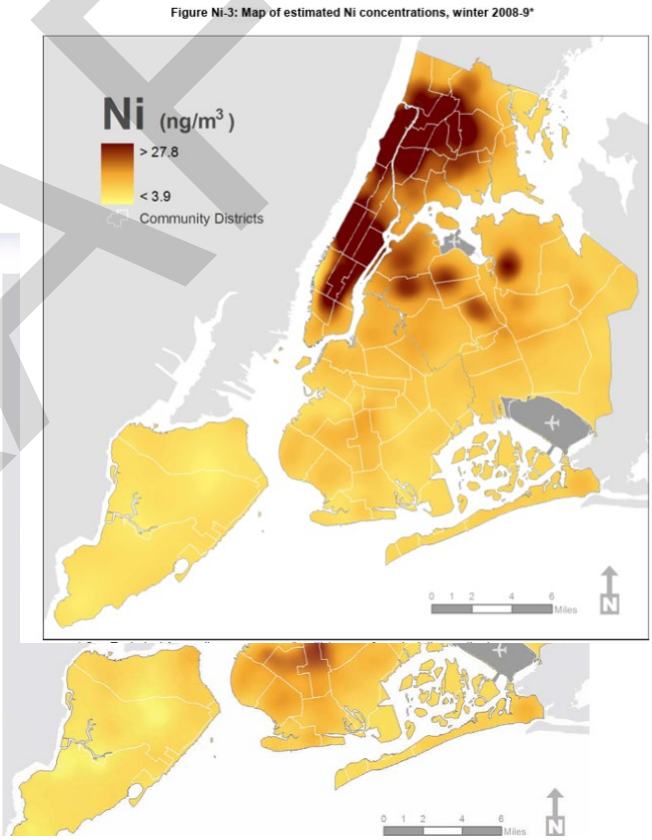
ı December 2008. The results of the first
e released as a "prepublication" report in
vey Results from Winter Monitoring 2008-
n May 2010 (*The New York City Community*
tions in Ambient Fine Particles: Winter
m the reports replicated below.

Figure SO_2-2: SO_2 levels are 150% greater in areas of high, compared to low, density of residual oil burning units



ppb= parts per billion
Density of residual oil burning units estimated as units using #4, or #6 heating oil within 1 km of sampling location. Each category (lower, medium, and higher) includes one-third of sampling sites, with counts of 0-3, 4-31, and 32-447 permitted oil burning units, respectively. Data source: NYC Department of Environmental Protection (DEP) permitting data.

Figure Ni-3: Map of estimated Ni concentrations, winter 2008-9*



[30] The New York City Community Air Survey Results from Winter Monitoring 2008-2009. 2009. City of New York. https://commonercenter.org/docs/comm-air-survey-winter08-09.pdf; The New York City Community Air Survey Supplemental Report - Nickel Concentrations in Ambient Fine Particles: Winter Monitoring, 2008-2009. 2010. City of New York. https://commonercenter.org/docs/nyccas-ni-report0510.pdf.

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The results were later more fully described in a peer-reviewed journal article,[31] and were corroborated by other academic papers published around the same time that showed clear evidence of elevated concentrations of nickel and vanadium in New York City relative to surrounding regions, with pronounced seasonal patterns,[32] thus implicating water- and space-heating boilers as a major source of these pollutants.[33]

The fact that some of the worst air quality in the City was in high-density areas with large buildings, including affluent neighborhoods on the Upper East Side, and that the buildings themselves were partly to blame, created a compelling narrative. The NYCCAS results and maps received considerable local news coverage,[34] with additional attention generated by parallel research from local advocates and researchers.

Academics and Environmentalists Refine Data on Pollution Sources

Around the same time that City experts were beginning to analyze the data from their Winter 2008-2009 survey, parallel efforts were underway by other local researchers.

Together with a coalition of other environmental and environmental justice organizations, the Environmental Defense Fund (EDF) had established itself as a champion for phasing out residual oil. One EDF advocate (and a co-author of this paper) went as far as to carry with her vials of black no. 6 oil and transparent, amber No. 2 fuel oil for viewing by the press, the public, and even Mayor Bloomberg, whom she respectfully confronted on several occasions with the visually-compelling examples of the vials.

[31] Clougherty, Jane E., Iyad Kheirbek, Holger M. Eisl, et al. 2013. “Intra-Urban Spatial Variability in Wintertime Street-Level Concentrations of Multiple Combustion-Related Air Pollutants: The New York City Community Air Survey (NYCCAS).” Journal of Exposure Science and Environmental Epidemiology 23 (3): 232–40.

[32] Peltier, Richard E., et al. "Residual oil combustion: a major source of airborne nickel in New York City." *Journal of exposure science & environmental epidemiology* 19.6 (2009): 603-612.

[33] Peltier, Richard E., and Morton Lippmann. "Residual oil combustion: 2. Distributions of airborne nickel and vanadium within New York City." *Journal of exposure science & environmental epidemiology* 20.4 (2010): 342-350.

[34] Buckley, Cara. 2009. “On Upper East Side (Gasp!), Some of the City’s Dirtiest Air.” New York. The New York Times, December 17. https://www.nytimes.com/2009/12/17/nyregion/17pollute.html.

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Photograph copyright EDF (2011), https://perma.cc/L9ML-JGE3.

But EDF wanted data to back up its advocacy. Under a local air code that predated the federal Clean Air Act, the New York City Department of Environmental Protection (DEP) issued permits for major sources – over 66,000 permits for combustion devices and boilers, of which 6,211 used No. 6 oil (up to 3,000 ppm sulfur) and 3,865 used No. 4 oil (1,500 ppm).[35] Partnering with the Urban Green Council and recruiting consultants from M.J. Bradley & Associates, EDF collected building permits filed with the city government to extract information on which buildings burned which heating fuel. Their analysis revealed that numerous Manhattan zip codes, including the Upper West and Upper East Sides, and the west Bronx had the highest concentrations of buildings that continued to burn residual oil. As EDF's report observed, those zip codes were often adjacent to some of the neighborhoods in the City with the highest asthma hospitalization rates and other indicators of poor air quality. The report (called "The Bottom of the Barrel") went on to outline some of the cost-effective options for converting boilers to cleaner fuels. Though the final version of the report was not published until December 2009—the same time as the NYCCAS prepublication results—early drafts and insights were widely circulating among stakeholders by the summer of 2009.

Meanwhile, academic researchers at New York University's Institute for Policy Integrity were investigating the same problem from a different angle. In the spring and summer of 2009, they developed source apportionment techniques using PM composition data to estimate the contribution of residual oil combustion to population exposure. By leveraging residual oil's unique chemical signature and the city air's seasonal and spatial variation in nickel and vanadium concentrations, the analysis was able to isolate the portion of $PM_{2.5}$ attributable to local residual oil use. The study further evaluated how alternative policy scenarios would affect exposure levels, with the resulting health benefits quantified. Though their first report (called

[35] Holloway.

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"Residual Risks"[36]) was not officially published until January 2010, a few weeks after the NYCCAS and EDF reports, the methodology was discussed with City health officials in the summer of 2009, and preliminary health estimates were widely circulated among stakeholders and policymakers in the fall of 2009. Additional press and public attention followed these publications as well.[37]

The results were compelling. As summarized in Policy Integrity's follow-up report published in May 2010 to take advantage of the newly released NYCCAS data on nickel,[38] converting all residual oil to natural gas would decrease $PM_{2.5}$ exposure associated with as many as 250 premature mortalities per year. Even just converting residual oil to either low-sulfur No. 4 oil or to distillate No. 2 oil would deliver meaningful health benefits, avoiding up to 85 premature deaths per year. But crucially, an intermediate option of converting to low-sulfur No. 2 oil could avoid up to 150 deaths per year, and likely at much lower cost than the full conversion to natural gas. This data would become important as the debates among stakeholders over policy options progressed and for a Mayoral Administration that used life expectancy as a key metric to drive smoking bans, calorie-labeling, and other public health measures.

Stakeholders Use Data to Move Toward Consensus

From the publication of PlaNYC, the Office of Long-Term Planning and Sustainability (OLTPS) had initiated a process of engagement with external partners such as Brookhaven National Labs, building owners, trade associations, energy supply companies, and public school operational staff, and had also conducted its own assessment of energy and equipment costs and financing options.

Those engagement efforts picked up in 2009. Stakeholder discussions were underway throughout the early and mid-portions of the year, involving City agencies, environmental organizations, technical experts, industry representatives, and labor groups. These conversations focused on identifying feasible pathways for reducing emissions from buildings, understanding fuel use patterns, and assessing operational and economic constraints. Engagement intensified during the summer and fall of 2009 as the City moved closer to defining a regulatory framework.

These discussions were not always aligned. Different stakeholders brought competing priorities to the table. Environmental organizations, including EDF, environmental justice organizations, and others, often advocated for more rapid or comprehensive transitions, such as an immediate shift to natural gas. However, building owners were concerned about natural gas prices, which

[36] Cromar, Kevin R., and Jason A. Schwartz. 2010. *Residual Risks: The unseen costs of using dirty oil in New York City boilers*. Policy Integrity Report No. 5. New York, NY: Institute for Policy Integrity, New York University School of Law. January 21, 2010.

[37] E.g., https://www.wnyc.org/story/32413-cost-of-nycs-dirty-oil/.

[38] Cromar, Kevin R., and Jason A. Schwartz. 2010. *More Residual Risks: An update on New York City boilers*. Policy Brief No. 8. New York, NY: Institute for Policy Integrity, New York University School of Law. May 2010.

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had been "spiky" over the prior decade as shown in EIA data,[39] and only a portion of the buildings burning residual oil had boilers that could readily switch to natural gas without potentially costly upgrades, retrofits, or replacements.[40] Labor representatives, including unions associated with fuel delivery, expressed concerns about potential supply disruptions and in some cases favored maintaining existing fuel use. The New York Oil Heat Association was eager to develop a cleaner product that could compete better with natural gas and, therefore, save market share for its membership of family-owned delivery companies. Even the City, though eager to make substantial environmental progress, had to balance the potential costs of converting public schools given competing capital demands. These differing perspectives reflected real tradeoffs between environmental ambition, economic feasibility, and workforce considerations, and contributed to a period of active negotiation during the policy development process.

By relatively late in 2009, a number of policy options still remained on the table. Some stakeholders and officials were still pushing for, at one extreme, citywide conversion to natural gas as quickly as possible. Meanwhile, at the other extreme, some stakeholders and officials were still wondering whether an approach focused on mostly voluntary conversions of the largest, richest buildings would be more cost conscious, with city regulation setting phase-out requirements on a long time-horizon as merely a backstop.

The data generated by the City, the environmental advocates, and the academic researchers helped move the stakeholders toward compromise. Two data points proved especially important. First, the fact that buildings in some of the city's most affluent neighborhoods disproportionally contributed to this particularly harmful and controllable type of air pollution meant inaction was not an option.[41] This unfair situation could not persist in a stalemate, and effectively all parties recognized that some progress had to be made. Second, while a full switch to natural gas would deliver the greatest public health gains, the fact that intermediate options

[39] The NYC price exceeded $7.50 per thousand feet and peaked at $10 between 2005 and 2010, compared to prices that fluctuated between $2.50 and $5 for the preceding 20 years. U.S. Energy Information Administration, open data, for natural gas citygate price in New York, accessed at https://www.eia.gov/dnav/ng/hist/n3050ny3a.htm, on March 22, 2026. A chart of monthly prices, however, shows frequent price spikes of more than $10 and approaching $15, including in 1997, 2006, and 2008. At the time, few foresaw that shortly thereafter natural gas prices would stabilize and lower with the influx of new supplies from Pennsylvania and the Marcellus Shale formation. Fracking started there in 2004, but production was insignificant until 2012. See https://www.resources.org/common-resources/fracking-and-politics-in-pennsylvania-assessing-the-economic-impact-of-the-shale-revolution-in-pennsylvania/ (Figure 201).

[40] Moreover, City permit data showed nearly 800 buildings had dual fuel boilers to burn natural gas and either No. 4 or No. 6 oil. Holloway.

[41] The Clean Heat Health Impact Assessment (HIA), showed that the overlap and geographic proximity of diverse neighborhoods—including very affluent ones with high consumption of and emissions from high-sulfur heating oil, together with low-income neighborhoods with greater chronic disease burdens—meant that estimated air pollution health impacts were especially large in environmental justice communities. Kheirbek, Iyad, Jay Haney, Sharon Douglas, Kazuhiko Ito, Steven Caputo Jr, and Thomas Matte. 2014. "The Public Health Benefits of Reducing Fine Particulate Matter through Conversion to Cleaner Heating Fuels in New York City." Environmental Science & Technology 48 (23): 13573–82.

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like conversion to low-sulfur distillate would have meaningful, quantifiable health benefits made that an attractive compromise.

And indeed, that option provided the basis for the solution soon enacted into law. The PlaNYC team developed a "drop-in" fuel strategy, in which cleaner No. 2 oil could be used directly in existing equipment with few if any modifications, while on a parallel path the sulfur content of No. 2 oil could be reduced. Expenses would be relatively modest, involving the removal of certain equipment used to pre-heat No. 6 oil so that the tar-like substance would flow into boilers. This was more economically feasible.

In a stakeholder environment characterized by competing priorities, concrete data provided a common evidentiary basis for evaluating policy options and helped clarify the tradeoffs associated with alternative approaches. The availability of quantitative health and economic estimates supported convergence around a phased transition strategy that could achieve large health gains while remaining feasible to implement.

Amending Local and State Laws

Much of the stakeholder engagement occurred in New York City Council hearings, and the legislative branch of local government would be critical to cement the heating oil policy in local law for a durable solution. The Council was a partner to the Administration and was intent on institutionalizing sustainability mandates, as it had done by amending the City Charter to require an update to the citywide sustainability plan every four years.[42] The State Legislature also had a small but critical role to play in securing the policy into law.

Since 1971, the NYC Air Code had limited the amount of sulfur in solid fuel (coal) to 0.7% by weight or 7,000 parts per million (ppm), in residual (No. 6) or No. 4 heating oil to 0.3% by weight or 3,000 ppm, and in No. 2 heating oil 0.2 percent or 2,000 ppm.[43] New York State law also limited No. 2 heating oil to 2,000 ppm, but did not address residual or No. 4 heating oil, presumably because those fuels were not used widely in the State and the market for residential heating with No. 4 or No. 6 was mostly limited to New York City with its concentration of large buildings.

To facilitate the creation of lower sulfur No. 4 oil, which was a blend of No. 2 and residual or No. 6 oil, the City worked with the State legislature to amend state caps on No. 2 sulfur content. Accordingly, the draft City Law provided time for that coordination with phase-in limits that went into effect more than two years later, on October 1, 2012. City representatives worked closely with environmental groups and, significantly, with the New York Oil Heat Association and industry groups, to lobby state elected officials to pass the laws.

[42] E.g., LL17/2008, LL5/2010, LL80/2020, LL135/2023, LL148/2025, LL149/2025.

[43] See NYC Air Pollution Control Code of 2014, Section 24-169, accessed at https://nycadmincode.readthedocs.io/t24/c01/sch08/#:~:text=The%20provisions%20of%20paragraph%201,society%20for%20testing%20and%20materials.

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In July 2010, state law was amended to require that all No. 2 heating oil sold in the state to have a maximum sulfur content of 15 ppm, known as ultra-low sulfur heating oil, by July 1, 2012.[44] This was the same sulfur content that a national standard already set for on-road diesel, and so the petroleum industry had already been producing this product for many years.[45] Additional lead times were provided so that refineries could ramp up production of ultra-low sulfur diesel for the new statewide heating oil market.

Then the City Council passed Local Law 43 on August 16, 2010,[46] with legislative findings citing NYCCAS data.[47] The law stepped down the sulfur content in No. 4 oil to 1,500 ppm.[48] In addition, Local Law 43 requires that all grades of oil used in the City contain two percent biodiesel, with certain provisions that were designed to encourage the use of waste oils, fats, or collected from restaurants[49] This element of the law was adopted after testimony that the biodiesel requirement would facilitate a market for the recycling of waste grease by the City's 20,000 restaurants and reduce illegal bypasses of grease traps [50]that caused sewer blockages.[51] That provision of the law was adopted for reasons other than air quality, but had the effect of broadening the stakeholders interested in its passage.

The New York City sulfur limits were implemented through DEP regulations and permits.[52] In the first phase, buildings with a permit to burn No. 6 oil would be required to switch to at least low sulfur No. 4 oil upon renewal of their three-year permit, which would occur between July 2012 and July 2015. In the second phase, buildings with a permit to burn either No. 4 and No. 6 oil would switch to No. 2 heating oil or natural gas whenever the boiler or burner is replaced between the effective date of the rule (2012) and January 1, 2030. By that date, all buildings still burning No. 4 oil will need to convert to cleaner fuel unless the DEP grants an extension in a

[44] Laws of New York, 2010, Chapter 203, July 15, 2010.

[45] EPA regulations phased in ultra-low sulfur diesel in the transportation market starting in 2006. See the regulatory timeline at https://www.epa.gov/diesel-fuel-standards/diesel-fuel-standards-and-rulemakings, accessed on July 4, 2026..

[46] NYC Council Legislative Research Center, accessed at https://legistar.council.nyc.gov/LegislationDetail.aspx?ID=660184&GUID=0F06CC07-D87E-42B1-8FB3-A7FB7E27CCCC&Options=ID|Text|&Search=sulfur on March 14, 2026.

[47] LL43/2010.

[48] Ibid.

[49] Ibid.

[50]

[51] Holloway, noting that DEP received over 31,000 sewer back-up complaints in FY 2009 and the U.S. Environmental Protection Agency estimates that nationwide, fats, oil and grease are responsible for over 45% of sewer obstructions.

[52] NYC DEP Rule (May 2011).

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compliance agreement. These phase-in periods were designed to allow buildings owners time to plan for equipment changes and to raise the relatively modest funds for conversion.

Subsequent City Council legislation moved up those deadlines for phasing out dirtier heating oils. This was due in large part to the dramatic drop in natural gas prices from the fracking boom, utility incentives to switch to natural gas, and OLTPS modeling and development of funding and financing programs like the Clean Heat Accelerator.

The various measures adopted in 2010 can be understood as the direct outcome of the iterative policy design, stpaakeholder engagement, and analytical work undertaken throughout 2009.

The Legacy of NYCCAS in NYC

Population health-focused exposure monitoring and policy development have been leveraged beyond heating oil, and in 2015, Local Law 103 made NYCCAS a mandated DOHMH activity.[53] NYCCAS methods and resources have also been leveraged in time limited campaigns to collect and map data on other environmental exposures, including toxic air pollutants,[54] pollen[55] , and noise.[56]

Other health impact and policy analyses were carried out using refined local emissions data and the modeling platform developed for the Clean Heat Health Impact Assessment. An enhanced on-road mobile source inventory using road link-level allocation of vehicle emissions was used to assess impacts of traffic pollution.[57] The results showed that heavy-duty diesel vehicles caused a large share of traffic-related ambient $PM_{2.5}$ and that estimated health impacts were greatest from traffic $PM_{2.5}$ in vulnerable disadvantaged communities. A greenhouse gas reduction strategy report[58] included those results in its assessment of transportation emissions in support of a plan to explore the feasibility low emission zones, which have been shown to

[53] Clean Air for Health. n.d. “New York City.” Accessed March 27, 2026. https://www.cleanairforhealth.org/newyorkcity.

[54] Kheirbek, Iyad, Sarah Johnson, Zev Ross, et al. 2012. “Spatial Variability in Levels of Benzene, Formaldehyde, and Total Benzene, Toluene, Ethylbenzene and Xylenes in New York City: A Land-Use Regression Study.” Environmental Health 11 (1): 51.

[55] Weinberger, Kate R., Patrick L. Kinney, Guy S. Robinson, et al. 2016. “Levels and Determinants of Tree Pollen in New York City.” Journal of Exposure Science and Environmental Epidemiology, ahead of print, December 21. https://doi.org/10.1038/jes.2016.72.

[56] Kheirbek, Iyad, Kazuhiko Ito, Richard Neitzel, et al. 2014. “Spatial Variation in Environmental Noise and Air Pollution in New York City.” Journal of Urban Health 91 (3): 415–31.

[57] Kheirbek, Iyad, Jay Haney, Sharon Douglas, Kazuhiko Ito, and Thomas Matte. 2016. “The Contribution of Motor Vehicle Emissions to Ambient Fine Particulate Matter Public Health Impacts in New York City: A Health Burden Assessment.” Environmental Health 15 (1): 89. https://doi.org/10.1186/s12940-016-0172-6.

[58] City of New York. 2016. New York City’s Roadmap to 80 x 50. City of New York Mayor’s Office of Sustainability. https://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/New%20York%20City%27s%20Roadmap%20to%2080%20x%2050_Final.pdf

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effectively reduce traffic pollution in London.[59] The same approach was later used to estimate the health benefits attributable to lower $PM_{2.5}$ levels if New York City's greenhouse gas emission reduction targets (80% by 2050) were met.[60] And the legacy of NYCCAS improved the assessment of the commercial cooking emissions, building on data collected by DOHMH restaurant inspectors, which was used to support the update of the NYC Air Code.

The Queens College team that developed the NYCCAS multipollutant integrated sampling unit later developed and deployed streetlamp-mounted real-time $PM_{2.5}$ monitors. DOHMH provided funding, determined monitor assignments, and provided near-real-time access and data visualization.[61] Additional monitors were placed with support from the Metropolitan Transportation Authority (MTA) in anticipation of the start of the city's traffic congestion pricing initiative in January 2025. These and other NYCCAS data are still being used to evaluate air quality changes associated with congestion pricing.[62]

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[59] "Inner London ULEZ One Year Report - Final.Pdf." n.d. Accessed March 27, 2023. https://www.london.gov.uk/sites/default/files/2023-02/Inner%20London%20ULEZ%20One%20Year%20Report%20-%20final.pdf.

[60] Johnson, Sarah, Jay Haney, Lia Cairone, Christopher Huskey, and Iyad Kheirbek. 2020. "Assessing Air Quality and Public Health Benefits of New York City's Climate Action Plans." Environmental Science & Technology, ahead of print, July 30. https://doi.org/10.1021/acs.est.0c00694.

[61] Environment & Health Data Portal. n.d.-c. "NYC Community Air Survey Annual Report." Accessed March 27, 2026. https://a816-dohbesp.nyc.gov/IndicatorPublic/data-features/nyccas/. See also Environment & Health Data Portal. n.d.-a. "Air Quality in Car-Free Areas." Accessed March 27, 2026. https://a816-dohbesp.nyc.gov/IndicatorPublic/data-stories/car-free-zones/; Environment & Health Data Portal. n.d.-b. "Air Quality in NYC." Accessed March 27, 2026. https://a816-dohbesp.nyc.gov/IndicatorPublic/key-topics/airquality/; Environment & Health Data Portal. n.d.-d. "Real-Time Air Quality in NYC." Accessed March 27, 2026. https://a816-dohbesp.nyc.gov/IndicatorPublic/data-features/realtime-air-quality/.

[62] NYCCAS, Air Quality Impacts of Congestion Relief Zone Tolling (August 14, 2026), accessed at https://a816-dohbesp.nyc.gov/IndicatorPublic/data-features/congestion-pricing-report/.

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Lessons for the Development of Urban Environmental Policies

The Clean Heat Initiative achieved significant impacts in less than five years after the adoption of PlaNYC in 2007. While the development of the policy appears logical and even inevitable in retrospect, at the time the success was far from certain. In addition to economic concerns during and after the Great Recession, the political calendar was a significant factor. Mayor Bloomberg's Administration was originally scheduled to leave office in December 2009, only two-and-a-half years after PlaNYC was adopted, and there were other important initiatives prioritized ahead of heating oil, including a slate of four local laws to reduce the carbon emissions from buildings that was known as the Greener, Greater, Buildings Plan.[63] Regardless of the time pressure, and perhaps because the legislative packages were not first-in-line, the multi-agency team worked deliberately with stakeholders to develop both a compelling factual case for change and feasible solutions that had widespread public support. That effort culminated in city and state legislative victories in 2010 and DEP regulations in 2011, with key implementation stages phased-in as early as 2012. By the end of 2015, over 5,000 buildings that had been using No. 6 oil had switched to cleaner burning fuel, which modeling showed would prevent 210 premature deaths and 540 hospitalizations each year.[64]

The success of this approach can be replicated in other areas. One key takeaway is that to achieve meaningful impact, regulators do not necessarily have to target the largest sources of air pollution but rather can focus on sources that are both large enough to have an impact and modifiable within economic and legal restraints. For cities that have limited authority to reduce the tailpipe emissions from vehicles or upwind power plants, such prioritization at the outset of policy initiatives is a more reliable path to achieving a cleaner environment and building momentum to take on other challenges. A second and related takeaway is that the identification of economically feasible solutions is critical. Many of the setbacks in environmental policy originate in the lack of cost-effective compliance pathways.

A final takeaway is that local capacity is critical to filling regulatory voids left by national and state authorities, who are focused on environmental problems at a different scale. Local permitting programs are an overlooked source of data and an important mechanism of control. Local public health expertise in government and academia can develop insights and information not available elsewhere. And local stakeholders are essential for the demanding work of creating consensus. These are important lessons because global cities have a role to fill regulatory gaps not addressed by national governments, including limiting building-level

[63] Local Laws 84, 85, 87, and 99 of 2009, passed by the City Council on December 9, 2009, and approved by the Mayor on December 28, 2009. These laws were passed in what would have been Mayor Bloomberg's last month in office had the two-term limit remained in place.

[64] DEP Press Release, Online Permitting, Additional Testing Options and Updated Emission Control Regulations Part of Air Quality Improvement Effort (August 25, 2017), accessed at https://www.nyc.gov/html/dep/html/press_releases/17-078pr.shtml#:~:text=As%20of%20December%2031%2C%202015,can%20now%20be%20done%20online on April 11, 2026.

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emissions from solid household fuels that have been identified as an important source of ambient air pollution.[65]

The Clean Heat Initiative reflects a policy development process in which early identification of a regulatory opportunity was followed by iterative refinement through analysis and stakeholder engagement. The alignment of policy objectives, technical evidence, and practical feasibility considerations enabled the City to develop and implement a targeted intervention that achieved substantial improvements in urban air quality.

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[65] S. Chowdhury, S. Dey, S. Guttikunda, A. Pillarisetti, K.R. Smith, & L. Di Girolamo, Indian annual ambient air quality standard is achievable by completely mitigating emissions from household sources, Proc. Natl. Acad. Sci. U.S.A. 116 (22) 10711-10716, https://doi.org/10.1073/pnas.1900888116 (2019).

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Proposed text box

Lessons for regulatory design

The Clean Heat Initiative was successful policy due to the fit between the goals and regulatory means. Its goal was to reduce population exposure to $PM_{2.5}$ and other criteria pollutants that caused the most public health harm from air pollution in New York City. Crucially, for a pollutant causing harm via direct inhalation by people, the location of emissions matters greatly. The large buildings that were using high-sulfur heating oil were not only major contributors to local $PM_{2.5}$ emissions, but they were also located in or near densely populated neighborhoods. Even with this tight connection between sources and receptors, the policy also required the availability of cost-effective means of switching fuels with minimal equipment (capital) upgrades. The regulatory design of targeting $PM_{2.5}$ pollution from a few large sources (buildings) near population centers was logical, efficient, and fair, but those factors may not be valid in other contexts.

For example, greenhouse gases (GHGs) have an impact because of atmospheric concentrations from contributions around the world from billions of point and area sources, both stationary and mobile. Meaningful reduction of GHGs requires attention to land use and transportation emissions from many sources as much as to any individual stationary source. Given these characteristics and finite resources for decarbonization efforts, the cost efficiency of GHG reduction is critical, and we can direct resources to where they reduce the most GHGs and therefore harm. (Who should pay raises separate fairness issues that can in theory be addressed separately).

The government, and cities in particular, should also minimize any unintended effects that will increase GHGs, such as the displacement of residents outside of cities to suburban areas where driving and other emissions will increase. For example, large multifamily buildings, which house a greater population density on a given land area, have per capita residential energy consumption (and thus GHG emissions) 70% less than that of single-family homes in the Northeast US (*2020 Residential Energy Consumption Survey, Forms EIA-457A, D, E, F, G of The* 2024). The lowest per capita greenhouse gas emissions are associated with densely populated areas like those where New York City's large buildings are most abundant; higher per capita emissions are associated with lower population densities and greater floor area per capita (Goldstein et al. 2020). Car ownership, vehicle miles driven, and transportation greenhouse gas emissions are also much lower in neighborhoods with population density and more residents in multi-family housing in comparison to suburban communities (Jones and Kammen 2014).

Applying narrowly-tailored, cost-efficient regulatory approaches to climate change should consider the feasibility and effectiveness of compliance costs and the potential for emissions being displaced from a local jurisdiction rather than avoided, to be in a holistic benefit-cost framework. This would produce a common reference for all stakeholders, if not full agreement. Without such an approach in place, regulatory compliance costs might not move the needle on global greenhouse gas emissions and could ultimately deter residents from living in New York City and adopting a low-carbon lifestyle.

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