

Industrial Revolution

Every home makes compromises among different and often competing goals: comfort, convenience, durability, energy consumption, maintenance, construction costs, appearance, strength, community acceptance, and resale value. Often consumers and developers making the tradeoffs among these goals do so with incomplete information, increasing the risks and slowing the adoption of innovative products and processes. This slow diffusion negatively affects productivity, quality, performance, and value. This department of Cityscape presents, in graphic form, a few promising technological improvements to the U.S. housing stock. If you have an idea for a future department feature, please send your diagram or photograph, along with a few well-chosen words, to elizabeth.a.cocke@hud.gov.

Clean Heat: A Technical Response to a Policy Innovation

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Abstract

NYC Clean Heat policy was enacted to improve air quality in New York City, with emphasis on reducing exposure to pollutants—black carbon, particulate matter, and sulfur—that are linked to environmental degradation and various health risks. This policy measure called for phasing out residual oil and adopting cleaner-burning fuel sources by converting boilers in commercial and residential properties throughout the city. This article describes the process of clean heat technology adoption within the innovative NYC Clean Heat policy context, demonstrating thorough compliance on the part of building owners and managers and discussing implications for scalability in other urban settings.

Introduction

Significant changes to the U.S. housing stock are often stimulated by market demands or policy changes. Both conditions exist in New York City (NYC). Market forces have created an increased demand for new housing developments at all levels of affordability (Kadi and Ronald, 2014). Policy

advancements simultaneously have served to improve the functional capacity of existing buildings (Tan et al., 2015). A recent policy measure issued by the NYC Department of Environmental Protection mandated that boilers providing heat and hot water in (mostly older) residential and commercial buildings phase out the use of No. 6 oil, a heavy-burning fuel source (NYC Department of Environmental Protection, 2011). The policy required conversion to cleaner-burning fuel sources including lower-sulfur No. 2 fuel, biodiesel or natural gas, and No. 4, a blend of No. 2 and No. 6 oils (exhibit 1), until 2030, when a stricter regulation goes into effect. This environmental and public health law was intended to address widespread air pollution by reducing fine particulate matter emissions that produce soot and black carbon in NYC (Seamonds et al., 2009). Because NYC is the most populated city in the United States, this regulation is one of the most consequential pieces of environmental, energy, and public health policy in the nation in the past decade.

Exhibit 1

Heating Fuels Implicated in NYC Clean Heat Policy



Source: NYC Clean Heat, <https://www.nycleanheat.org/content/problem>

This article reviews key tenets of the NYC Clean Heat policy regulations and describes the technical responses available to building operators for achieving compliance. Acceptable changes ranged from minor retrofitting of boilers to the installation of modern, more efficient mechanical systems coupled with energy-efficiency upgrades. The discussion section highlights the benefits, drawbacks, and information gaps associated with the policy as other jurisdictions consider adopting similar measures.

Rationale for Clean Heat Policy

Previous research has demonstrated that residual oil represents a significant environmental and public health threat (Cromar and Schwartz, 2010; Seamonds et al., 2009). In addition to polluting the air, residual oil is linked to such health problems as cardiovascular disease, respiratory illness, and impaired cognitive function (Brook et al., 2010; Cornell et al., 2012; Suglia et al., 2008). Buildings that burn residual heating oils (exhibit 2), including No. 6 and No. 4, significantly contribute to the city's current emissions of black carbon, particulate matter 2.5, and sulfur (Cromar and Schwartz, 2010; Seamonds et al., 2009).

NYC Clean Heat policy was a measure enacted in 2012 to address the hazards associated with heating oil emissions. The conversion regulation called for more than 6,000 buildings to convert from No. 6 oil to a cleaner fuel by 2015 and has achieved a nearly perfect level of compliance (exhibit 3), with a mere 20 buildings still running No. 6 in NYC as of this writing (NYC Clean Heat, n.d.a.). It is estimated that this initiative has decreased related emissions by as much as 65 percent, resulting in cleaner air and reduced health risks (NYC Clean Heat, n.d.b.). A multipronged technical response was instrumental in achieving these important results.

Exhibit 2

Emissions Stemming From Residual Oil Use in a Large Residential Building in New York City, 2013



Photo credit: Tomás Guilarte (2013)

Exhibit 3

New York City Building That Transitioned From No. 6 to No. 4 Oil During the Clean Heat Policy Implementation Period



Photo credits: Diana Hernández (2013, 2016)

Clean Heat Technical Responses

Building operators affected by this policy measure were required to install new boilers or burners using, at a minimum, No. 4 oil or cleaner options such as ultra-low-sulfur No. 2 oil, natural gas,

biodiesel, or steam. Of these options, most boilers were converted to No. 4, followed by No. 2, and natural gas. Many operators also took the opportunity to install dual-burner boilers running No. 2 and natural gas (similar to the boiler in exhibit 4) to contain costs and ensure reliability of building heat. Building operators who opted to make the minimal shift to No. 4 oil will be required to adopt one of the cleaner options by January 2030 to complete the phaseout of heavy heating oil and comply with NYC Clean Heat regulations and other city plans. Building operators were given administrative support and financing help to ensure compliance. Enforcement was tied to the renewal of boiler permits; violations and fines were issued for noncompliance.

Building operators also were encouraged to implement energy-efficiency measures for improved performance and increased cost savings. Furthermore, most buildings mandated to transition to cleaner fuel were also required to comply with the 2009 Greener, Greater Buildings Plan laws,¹ which called for energy benchmarking and better energy performance in large commercial and residential buildings. The energy-efficiency measures that were coupled with fuel conversion included installing heat management systems with indoor temperature sensors, installing burner and draft controls to increase boiler efficiency, and implementing weatherization techniques to reduce heat loss and increase comfort. Many building operators took advantage of the opportunity to upgrade building efficiency and applied for related financial incentives.

Exhibit 4

New Dual Burning Boiler (No. 2 Oil and Natural Gas) in Residential Building Formerly Using No. 6 Oil To Provide Heat and Hot Water



Photo credit: Diana Hernández (2013)

Discussion

By phasing out the use of residual oil for heating purposes, the NYC Clean Heat policy initiatives were successful in reducing a prominent source of air pollution in New York City. Spanning only four heating seasons from 2012 to 2015, the conversion timeframe was short, but 99.8 percent conversion compliance was achieved. The conversion initiative confers several benefits. First, building operating costs and procedures were improved by incorporating cleaner, more reliable

¹ http://www.nyc.gov/html/planyc2030/downloads/pdf/greener_greater_buildings_final.pdf.

fuel sources; participating buildings achieved significant cost savings (NYC Clean Heat, n.d.c.). Second, air quality has improved dramatically. Compared with air quality measures from 2008 to 2011, recent estimates of air quality demonstrate a significant decrease in particulate matter and sulfur oxide, in large measure attributable to NYC Clean Heat regulations (NYC Community Air Survey, 2016). Third, health risks related to black carbon emissions—including cardiovascular, respiratory, and neurological disorders—are expected to decline significantly with improvements in air quality spurred by the NYC Clean Heat policy, albeit the public health effect for local residents may not be fully documented for some time.

Although NYC Clean Heat initiatives are promising, they leave unanswered questions about the geographic distribution of the cleanest (or dirtiest) heating sources, the incorporation of renewable energy, and the economic consequences to fuel providers and others whose incomes were negatively affected by the changes. A major shortfall of the policy reform is the extended time allotted to complete the phaseout of heavy fuel sources. As indicated previously, most buildings opted to transition to No. 4 oil—which, although cleaner than No. 6, is still considered a dirty fuel. Policymakers, advocates, and public health officials should consider shortening the time frame to phase out No. 4 so the benefits of cleaner air can be secured long before 2030. Systematic evaluation of the effect of such policy is critical as other cities weigh the benefits of transitioning to cleaner fuel sources.

Conclusion

Long recognized as a dirty city, NYC has made significant strides in sanitizing its air quality by implementing a comprehensive Clean Heat policy. The technical responses to the policy ranged from simply shifting to a slightly cleaner fuel source to conducting a major overhaul of heating systems, which included incorporating energy-efficiency measures to improve the overall performance of buildings. In light of NYC's aging housing stock, NYC Clean Heat policy offered a promising approach for modernizing building functions and addressing environmental and public health concerns one boiler at a time.

Acknowledgments

The author acknowledges support from the National Institute of Environmental Health Sciences under grant numbers R21 ES02410801 and P30ES009089. This work was also sponsored by a JPB Environmental Health Fellowship granted to the author and managed by the Harvard T.H. Chan School of Public Health Grant.

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References

Brook, R., S. Rajagopalan, C. Pope, J. Brook, A. Bhatnagar, A. Diez-Roux, F. Holguin, Y. Hong, R.V. Luepker, M.A. Mittleman, A. Peters, D. Siscovick, S.C. Smith, L. Whitsel, and J.D. Kaufman. 2010. "Particulate Matter Air Pollution and Cardiovascular Disease: An Update to the Scientific Statement From the American Heart Association," *Circulation* 121 (21): 2331–2378.

Cornell, A., S. Chillrud, R. Mellins, L. Acosta, R. Miller, J. Quinn, and M. Perzanowski. 2012. "Domestic Airborne Black Carbon and Exhaled Nitric Oxide in Children in NYC," *Journal of Exposure Science and Environmental Epidemiology* 22 (3): 258–266.

Cromar, K.R., and J.A. Schwartz. 2010. "Residual Risks: The Unseen Costs of Using Dirty Oil in New York City Boilers." Institute for Policy Integrity, New York University School of Law, Report No. 5. <http://policyintegrity.org/files/publications/ResidualRisks.pdf>.

Kadi, J., and R. Ronald. 2014. "Market-Based Housing Reforms and the 'Right to the City': The Variegated Experiences of New York, Amsterdam, and Tokyo," *International Journal of Housing Policy* 14 (3): 268–292.

New York City Department of Environmental Protection. 2011. "Promulgation of Amendments to Chapter 2 of Title 15 of the Rules of the City of New York Rules Governing the Emissions from the Use of #4 and #6 Fuel Oil in Heat and Hot Water Boilers and Burners." http://www.nyc.gov/html/dep/pdf/air/heating_oil_rule.pdf.

NYC Clean Heat. n.d.a. "Buildings Burning Heavy Oil." *Spot the Soot*. <https://www.nycleanheat.org/spot-the-soot>.

———. n.d.b. "Program Progress." <https://www.nycleanheat.org/content/program-progress>.

———. n.d.c. "Case Studies and Testimonials." <https://www.nycleanheat.org/content/case-studies-and-testimonials>.

NYC Community Air Survey. 2016. "Neighborhood Air Quality 2008–2014." <https://www1.nyc.gov/assets/doh/downloads/pdf/environmental/comm-air-survey-08-14.pdf>.

Seamonds, D., D. Lowell, T. Balon, R. Leigh, and I. Silverman. 2009. "The Bottom of the Barrel: How the Dirtiest Heating Oil Pollutes Our Air and Harms Our Health." http://www.edf.org/sites/default/files/10085_EDF_Heating_Oil_Report.pdf.

Suglia, S.F., A. Gryparis, R.O. Wright, J. Schwartz, and R.J. Wright. 2008. "Association of Black Carbon With Cognition Among Children in a Prospective Birth Cohort Study," *American Journal of Epidemiology* 167 (3): 280–286.

Tan, D., M. Baxter, E. Leung, M. Meyer, L. Gao, J. Manning, B. Sugano, D. Lu, S. Yang, and H. Zhou. 2015. Advancing Energy Efficiency in New York City Multifamily Buildings. Capstone Project, Master's Program in Environmental Science and Policy, School of International and Public Affairs, Columbia University.