Analysis and Recommendation of Energy Efficiency Upgrades in New York City's Upper West Side:

A comprehensive guide for residential Upper West Side cooperative buildings

Prepared for Better Buildings New York

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"Lead the effort to preserve, strengthen, and grow thriving communities by improving our buildings. Our work changes lives, improves neighborhoods, and makes New York always feel like home. We provide a strong voice for New Yorkers who support our working neighbors, demand that New York reduce its environmental impact, and recognize that big buildings require big planning."

More information about BBNY can be found at http://www.betterbuildingsny.org/about.php.

This report served as the 2011-2012 Master's Project for the five authors, who are all second-year Master of Environmental Management students at the Nicholas School of the Environment at Duke University.

More information about the authors can be found at http://sites.duke.edu/bbnypolicymakerefficiencyguide/bios/.

Please see the website below for the authors' Master's Project website, which provides an overview of this report. http://sites.duke.edu/bbnypolicymakerefficiencyguide/

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Executive Summary

Nearly 9,000 buildings in New York City burn what is known as residual fuel oil (No. 4 or No. 6 heating oil) – an extremely dirty heating source that is harmful to the citizens of New York City. These buildings, which represent only 1% of New York City's total building stock, account for 86% of the city's oil heating soot pollution, while also emitting significant amounts of greenhouse gases such as carbon dioxide. [i]

Manhattan's Upper West Side (UWS), while only representing 0.82% of New York City's land mass and 3% of its population, possesses 11% of the city's No. 6 oil burning buildings.[iiiii] Like all of New York City's neighborhoods, the UWS has its own particular stock of buildings, access to infrastructure, and community makeup. The authors of this report, at the request of our client (Better Buildings New York), have directed our study at the consumption pattern and energy-related actions of residential cooperative (co-op) buildings in the UWS[1]. This report is set against the backdrop of PlaNYC – the long-term environmental plan for New York City that aims to build a greener city with lower carbon emissions by 2030.

We provide an initial list of recommendations and methods for adoption that will provide a solid foundation upon which co-op shareholders, management agencies, and local policymakers can rely when considering energy-related investments in their respective buildings. We believe that these entities should prioritize these investments for three main reasons: to comply with the goals and mandates of PlaNYC, to help generate financial savings for the building and its occupants, and to contribute to the curtailment of pollution in New York City and the effects of global climate change.

Examples of potential benefits regarding heating fuel conversion include:

- A conversion from No. 6 oil to a dual fuel system (utilizing No. 2 oil and natural gas), can save an average co-op residential UWS building $45,000 a year in heating expenses, recover fuel conversion capital costs ($119,500) in under 3 years, and reduce its annual particulate matter and carbon dioxide emissions by 95% and 23% respectively.
- If the specific Upper West Side buildings analyzed in this report (186 buildings) were to redirect 50% of their No. 6 oil consumption to a dual fuel set-up, the aggregate group of buildings could save around $3.6 million annually on fuel costs, a 9% savings from the business as usual case. This shift would be equivalent to taking over 350,000 passenger cars off the road in terms of particulate matter emissions and about 4,800 cars in terms of carbon dioxide emissions. Furthermore, the savings in sulfur dioxide emissions is equivalent to preventing the pollution from coal plants that stems from the annual generation of electricity for 80 American homes.

Environmental Issues

In 2008, residential and commercial buildings accounted for nearly 39% of total U.S. energy consumption and 38% of U.S. greenhouse gas emissions[iv]. Furthermore, in 2010, 31% of New York's citywide CO_2 emissions came from large residential buildings.[vvi] The fossil fuel consumed in New York City's buildings is especially worthy of

[1] Upper West Side buildings that meet the following criteria: located in zip codes 10023, 10024, or 10025; 30+ residential units (Asylums and Homes, Walk-up Apartments, Elevator Apartments, Loft Buildings); co-op structured; primary heating fuel is No. 6 oil.

study, not only because these buildings consume a substantial amount of energy, but also because of the special environmental and health issues arising from burning residual heating oil in the UWS.

No. 2 heating oil (left) and No. 6 heating oil (right)

Residual heating oil has caused environmental problems that directly affect people's health and daily lives. By using residual heating oil, residential, commercial and institutional heating systems release 50% more fine particulate matter ($PM_{2.5}$) and 17 times more SO_2 than cars and trucks on New York City's roads. This has contributed to New York City having twice the national asthma hospitalization rate among children age 0-14 years, with over 300,000 New York City children having been diagnosed with asthma.

The urban heat island effect is another environmental issue facing New York City. The term 'heat island' refers to built-up urban areas that are hotter than nearby rural areas. The difference in annual mean air temperature can be as high as 1-3 degrees Celsius[vii]. The main reason for this difference is the presence of heat-absorbing roofs and other paved surfaces in urban areas. Elevated temperatures due to the urban heat island effect, especially during the summer, have many negative impacts that include increased energy consumption, increased emissions of air pollutants and greenhouse gases that reduce air quality, compromised human health and comfort, and impaired water quality.[viii]

Lastly, electricity consumption is a concern due to the emissions from fossil fuel burning power plants that generate electricity. By reducing electricity consumption overall, fewer new plants will be built and current plants will reduce their output, which in turn reduces emissions. This reduction in emissions through increased energy efficiency improves air quality and prevents more greenhouse gases from entering the atmosphere.

PlaNYC

PlaNYC is the long-term environmental plan for New York City, aiming to build a greener city with lower carbon emissions by 2030. The Greener, Greater Building Plan (GGBP), a part of PlaNYC, is a direct commitment to addressing energy efficiency in the city's existing building stock. The GGBP mandates that all buildings noted here[2] will be required to benchmark energy use, conduct audits and retro-commissioning of the building, and begin the conversion to both better lighting and also sub-metering.

Through Initiative 8 in PlaNYC, the Mayor's Office is committed to ridding No. 4 oil and No. 6 heating oil from buildings of 50,000 square feet or more (this includes all 186 buildings in our study and about 10,000 buildings city-wide). The Department of Environmental Protection (DEP) and Department of Buildings (DOB) in May of 2011 began implementing the initiative, which will occur in several parts[ix]:

1. As of **May 23, 2011**, any newly-installed boilers will be required to only burn No. 2 heating oil, natural gas, or the equivalent from an emissions standpoint.

[2] Selection is based on the square footage of property. An updated list is being generated for 2012 – if your building is covered, you will have received a letter of compliance from the NYC Department of Finance in 2011. Visit http://www.nyc.gov/html/planyc2030/downloads/pdf/120210_benchmarking_compliance_list02-10-12.pdf to determine if your building is covered under the Greener, Greater Buildings Plan.

2. Starting on **July 1, 2012** upon expiration of a building's DEP boiler permit, the building will be required to switch from No. 6 oil to at least the new low sulfur No. 4 heating oil or to an equivalent cleaner fuel such as No. 2 heating oil or natural gas.
3. By **July 1, 2015**, all No. 6 oil buildings will have to have converted to a cleaner fuel unless they were given an extension by the DEP.
4. As of **May 23, 2011**, all No. 4 oil buildings will need to switch to No. 2 oil or natural gas upon boiler or burner replacement.
5. As of **October 1, 2012** all No. 4 oil buildings must switch to cleaner low sulfur No. 4 oil which does not require any equipment adjustments.
6. By **2030**, all No. 4 oil buildings must switch to low sulfur No. 2 oil, natural gas or an equivalent cleaner fuel.

Fuel Conversion

Using financial and energy modeling, our report analyzed three potential fuel conversion scenarios. Below are the economic, regulatory and environmental outcomes of each scenario for the average UWS building in our area of study[3]:

Conversion Scenario	Economic Outcome	Complies with GGBP?	Emissions Reduction
No. 6 → No. 2 (w/boiler efficiency measures)[4]	Financially unattractive due to increased use and cost of No. 2 oil	Both 2015 and 2030 mandates	• PM: 94% • SO_2: 75% • NO_x: 72% • CO_2: 25%
No. 6 → Dual Fuel[x]	• **$44,910** annual savings in fuel costs • **$119,500** in conversion capital costs • Basic payback period of **2.66** years	Both 2015 and 2030 mandates	• PM: 95% • SO_2: 92% • NO_x: 72% • CO_2: 23%
No. 6 → Natural Gas	• **$55,145** annual savings in fuel costs • **$119,500** in conversion capital costs • Basic payback period of **2.17** years	Both 2015 and 2030 mandates	• PM: 95% • SO_2: 100% • NO_x: 75% • CO_2: 29%

Our final recommendations include the following:

- All buildings currently burning No. 6 oil should begin planning conversion of heating fuel from No. 6 to either a dual fuel system or solely natural gas, due to both relatively quick economic paybacks and significant emission reductions. Buildings should continue to monitor GGBP mandates and fuel markets (natural gas).

[3] Average UWS building: Annual energy consumption = 13,040 mmBTU, consumption rate = 9.89 mmBTU/hour, amount of No. 6 oil previously needed = 86,933 gallons

[4] Conversion includes the implementation of various boiler efficiency measures that reduce overall fuel consumption by 20%. Measures include: regular maintenance of heating and hot water systems, regular boiler tube cleaning, yearly combustion efficiency tests, air/fuel ratio adjustment, maintenance of steam traps, air valves and shutoff valves on all radiators.

- Boilers that are already dual fuel capable (30.7% of boilers in our area of study) should begin transition from No. 6 oil to a dual fuel system. Identify needed (if any) installation of natural gas infrastructure.
- Large buildings with electric bills higher than $100,000 per year and with high domestic hot water or space heating demand should consider installing a cogeneration system and apply for relevant incentives.

Energy Efficiency Technologies and Methods

Heating Controls & Proper Maintenance

Heating controls provide additional diagnostics and feedback into a heating system to better regulate the temperature within a building. Diagnostic controls can determine where there are inefficiencies in the system and when maintenance will be required. Proper maintenance will ensure that the system is running at maximum efficiency. Control technologies can make heating systems "smarter" by basing heating needs on building internal temperature instead of simply outside temperature. Such a smart system will ensure that temperatures are comfortable for residents. Using these methods together can reduce fuel consumption up to 40%, which in turn saves money and reduces the combustion of fossil fuels to power boilers.

Lighting & Appliances

The electricity, heating, and hot water consumed in New York City's buildings add up to $15 billion per year in energy costs.[xi] Upgrades to lighting and appliances represent opportunities for significant reductions in energy costs and consumption. Standard incandescent light bulbs, for example, lose up to 90% of the electricity they consume through heat. Purchasing more efficient bulbs, such as CFLs or LEDs, and adopting other lighting efficiency strategies can significantly reduce electricity consumption. A simple switch from a standard incandescent 60 watt bulb to an LED equivalent, assuming twenty-four hours of use per day, can save as much as $45.28 a year per bulb.[xii]

Similarly, upgrading appliances to more efficient models such as ENERGY STAR certified appliances can yield impressive energy savings.

Sub-metering

Many of the multifamily apartment buildings in New York City are still master-metered, meaning the building receives only one electric bill for the entire building. Residents are then charged in proportion by their shares. A sub-metered building has a master-meter for the entire building *and* separate meters for each apartment. With this setup, the building is able to purchase electricity on a bulk rate basis, but each resident's utility usage is accurately measured and they are charged only for the electricity they consume. This can provide an incentive for residents to lower their electricity consumption. Installing sub-meters reduces electricity consumption in apartments by 10-26%.[xiii] The savings increase over time through changes in residents' energy conservation behaviors and investments in more energy-efficient appliances and lighting.

Building Envelope

The building envelope is the physical separator between the interior and the exterior environments of a building that maintains the indoor environment, including the foundation, roof, walls, doors and windows[xiv].

The buildings in our study have elevated space heating needs because of their inefficient envelopes. Improving the exterior building envelope can include using emerging insulating practices[xv], installing energy efficient windows, and improving sealing throughout the building. Improving the envelope then allows the building to

downsize the HVAC system, saving a significant amount of money. Performing this kind of retrofit has great potential to reduce heating and cooling load – usually between 40-60%.

Green & Cool Roofs

Green and cool roofs can be used to mitigate the urban heat island effect. By absorbing solar energy and insulating the roof, a green roof minimizes unwanted heat transfer to and from the building. Apart from reducing energy use through reduced heat transfers, green roofs have the added advantages of improved storm water management, direct air quality improvement and greenhouse gas reduction through photosynthesis, improved aesthetics and potential appreciation in property value.

A cool roof reduces heat transfer through increased light reflectance, but lacks the additional benefits of a green roof. However, it is only marginally more expensive than the installation of a normal roof, and it thus a small investment that can generate significant energy savings. Important to note is that energy-saving benefits are greatest for the top-most floor of the building, with diminishing returns for lower floors.

Demand Response

Demand response (DR) programs incentivize buildings to immediately reduce their electricity demand when requested by a utility in return for a cash payment and energy use analytics. The utility will call upon a building to reduce demand only when electricity demand approaches the capacity of the grid, usually only once or twice a year during the hottest summer days. Demand reduction events may last a matter of minutes to a few hours in which buildings may decide how they will reduce demand. Such options include cycling (but not turning off) air conditioners, shutting down a bank of elevators, or reduced lighting. The building may function at near full capacity while providing little inconvenience to residents over a small time window each year. Depending on building size, a building may contact Con Edison directly or go through a DR provider. For a list of these companies please visit Con Edison's Demand Response Provider page.[5]

Demand response can provide up to thousands of dollars of payments for little to no capital expenditure. Additionally, depending on the program, DR service providers may include electricity analytics software that buildings can use to find additional opportunities for reducing electricity consumption.

Barriers to Energy Efficiency Adoption

For many of the technologies and retrofits that we have discussed, upfront costs are probably one of the biggest barriers to adoption. Especially in the case of boiler replacement, these costs can be high enough to deter building managers from investing in these technologies, despite the fact that the payback periods are short and a switch to a 'cleaner' boiler results in significant savings in maintenance costs. The fact that many of the older boilers will become obsolete and unusable following a ban on No. 6 oil in the near future needs to be highlighted in order to encourage building managers to invest in new boilers, despite the high upfront cost. Additionally, like in the case of improved lighting and appliances, buildings may not have access financing to make the investment.

Lack of knowledge and awareness about the role of buildings in energy demand, greenhouse gas emissions, air quality and the urban heat island effect is another strong barrier to the adoption of these 'cleaner' technologies

[5] The list of providers is located at http://www.coned.com/energyefficiency/PDF/Demand%20Response%20Providers%20or%20Aggregators.pdf

and retrofits. If shareholders and building managers are not aware of the economic and environmental benefits of energy efficient technologies, they are less likely to adopt them when initially proposed.

The adoption of natural gas also faces some strong barriers that include infrastructure and public opposition. Although the buildings in our study may already have piping for domestic natural gas (i.e. for stoves and dryers), they need more supply in order to adopt gas as a primary heating fuel. Thus, the building requires an upgrade in the distribution line bringing gas into the building. In order to upgrade the distribution line, the building will need the cooperation of Con Edison who will need to install a larger pipe and make the connection to the building. If the building is near a major gas line, Con Edison might do this installation for free in return for the building accepting a firm, uninterruptable gas rate for the next few years. However, if the building is far from these lines or too small, Con Edison may refuse to install new piping because it cannot justify the expense.

At a larger scale, New York City's natural gas infrastructure is also limited. As the base of gas-burning buildings grows, Con Edison and others will need to expand supply into the city. At this point, new transmission has been approved by the Federal Energy Regulatory Commission for Spectra Energy to extend their Texas Eastern Pipeline 20 miles through New Jersey into lower Manhattan (expected completion by end of 2013)[xvi].

Another barrier to the adoption of natural gas is citizens and environmental groups that are opposed to the use of natural gas. These groups held rallies with state politicians and celebrity activists and spent money on extensive advertising and awareness campaigns. Although natural gas may be a cleaner burning fuel than heating oil, these environmental groups take issue with the methods used to extract the resource, more specifically, hydraulic fracturing (HF), or what is commonly called "fracking". Anti-fracking groups are concerned about HF's effect on water and air quality. However, the EPA has not definitively concluded that HF causes groundwater pollution, but as of December 2011, the EPA came out with an announcement that HF is a 'likely cause of water pollution'[xvii]. As of 2012, New York State continues to have a moratorium on drilling until more research is done on HF's potential effect on pollution and the best ways to regulate it[xviii]. Until regulations can catch up with the possible environmental issues of hydraulic fracturing, some co-op shareholders may be uncomfortable with a switch to natural gas as a primary heating fuel and politicians may avoid natural gas mandates or the creation of programs to encourage natural gas usage.

Recommendations to Improve Adoption

Although we discuss various technologies and methods that buildings can employ to save on energy costs, it is just as important to suggest how these technologies can be adopted. Although all of our recommended technologies will save money and improve the environment, based on the barriers that we mentioned above, buildings may still not adopt these recommendations. Thus, we propose a few methods to enhance adoption.

Cluster Demand for Natural Gas – If a building is not large enough nor near a major gas line, then Con Edison may not decide to extend a connection to a building demanding natural gas. To combat this problem, buildings managers should contact nearby buildings on their block and ask if they are demanding natural gas heat. If a cluster of buildings on the same block are demanding natural gas, then Con Edison will more likely make the connection to all of those buildings to lock in hundreds of not thousands of residential units as customers. BBNY should work with CB7 to develop of registry of buildings that demand natural gas and pass this list to Con Edison so they know the demand in the area and can plan to connect more buildings.

Plan Natural Gas Supply for the Future – The city should work with Con Edison to ensure that the infrastructure will be in place to serve new demand. From a transmission standpoint, New York will have ample supply when the East Texas Transmission pipeline extension to lower Manhattan is constructed by the end of 2013. However, Con Edison will be responsible for the development of more distribution lines. Thus, the city will need to work with Con Edison if there is a forecasted distribution installation bottleneck. More distribution will allow for Con Edison to serve more buildings with natural gas.

Develop UWS Purchasing Cooperative – Efficient lighting and appliances may have larger upfront costs. To mitigate this problem, buildings on the UWS can combine to increase their purchasing power through forming a cooperative. If a building is not managed by a major management agency, forming a group that represents the purchasing needs of hundreds of buildings with 10,000+ units will increase purchasing power and reduce prices for all buildings in the purchasing cooperative. We recommend BBNY work with CB7 to explore the idea of developing such a cooperative.

Use Financing Programs – To mitigate the upfront costs of energy efficient technologies, such as LED lighting, there are a handful of firms that can finance the purchase of upgrades. Buildings can then purchase these upgrades while only having to pay a lower monthly lease payment to get the efficiency benefits immediately. We recommend using these financing programs if buildings do not have the cash on-hand for upgrades.

Expand Grant and Loan Programs – Although these programs exist, they only target low-income areas. Grant and loan programs should expand so all buildings in New York City can improve their efficiency and reduce their environmental impact with greater ease. Although city and state budgets may be tight, low-interest loans can be used in place of grants so buildings will still pay for their improvements, but it will greatly reduce upfront costs. BBNY should work with CB7 to advocate the expansion of city or state level financing programs.

Enhance Information Sharing – In many instances, building managers and co-op shareholders simply do not know of the entire array of solutions that they can employ to make their buildings more efficient. A lot that can be learned through sharing experiences, thus we propose the creation of a quarterly conference for building managers and co-op board members where ideas about energy efficiency can be shared amongst participants. Meetings such as these can simply occur within a common meeting room that many buildings have so that the meeting has little to no cost.

Create Educational Campaigns – Residents should learn about how their choices affect energy use. Co-ops can develop educational campaigns to create awareness. Educational campaigns can be something as simple as posting energy use facts in the lobby, elevators, or other high traffic areas. If residents know they can save on their energy bills by making some simple choices, some will respond. Additionally, awareness of energy usage will allow residents, who are also shareholders, to be more informed when the co-op board puts energy efficiency upgrades to a vote. BBNY should work on a standard set of materials to send to co-op boards and building managers that will contain the most compelling arguments for reducing energy consumption. We believe this document to be an excellent foundation for that "standard set of materials".

Incorporating any of these suggestions will help in technology adoption. Although the merits of the technologies mentioned in this report are plenty to encourage adoption, there are reasons why these are not immediately adopted. Using the above recommendations will help to get around the barriers of adoption and will lead to cleaner, greener buildings for both the UWS and the rest of New York City.

Purpose & Outline of Report

Nearly 9,000 buildings in New York City burn what is known as residual fuel, (No. 4 or No. 6 heating oil) – an extremely dirty heating source that is harmful to the citizens of New York City. These buildings, which represent only 1% of New York City's total building stock, account for 86% of the city's heating oil soot pollution[xix]. Many of these buildings, especially high-rise residential buildings, were constructed before World War II and as a result are incredibly energy inefficient. And while the heating source is the overarching issue with these buildings, there are several other aspects of buildings that can be addressed with the goal of increasing energy efficiency.

Manhattan's Upper West Side (UWS), like all of New York City's different neighborhoods, has its own particular stock of buildings, access to infrastructure, and community makeup. Among those buildings are high-rise, cooperative residential buildings which house thousands of New York City citizens. These buildings are the focus of this report.

Our team evaluated these high-rise co-op buildings, as well as the infrastructure, environment, and community of the UWS. We made recommendations on what building improvements should be prioritized in order to decrease energy consumption, decrease energy costs, and increase the cleanliness of the air. The following pages provide an introduction and background of topics specifically related to environmental and energy issues, the background of the UWS, and current regulatory structures that directly drive many of our final conclusions. It will also evaluate the role that building management structures and different stakeholders have on potential energy efficiency upgrades in the UWS.

Next, the report offers a background, detailed analysis, and a set of recommendations that relate to the following potential energy efficiency upgrades: heating fuel conversion and heating system operation, lighting retrofits, sub-metering, building envelope, green roofs, and demand response. Lastly, the report addresses barriers to adoption and concludes with advice on how to implement the specific recommendations that our team developed.

A summary version of this report will be disseminated to BetterBuildingsNY, Community Board Seven (CB7), shareholders of co-op residential buildings on the UWS, and other interested parties. Our set of recommendations stemming from our analyses will provide the crucial information that is needed by decision makers on the UWS when discussing potential energy efficiency improvements to high-rise co-op residential buildings and improvements in community infrastructure.

Environmental and Energy Issues

Energy consumption by way of burning fossil fuel contributes the most to human-caused greenhouse gas emissions. In 2010, 41% of all energy consumption in the United States was represented by the energy use of residential, commercial, and industrial buildings[xx]. The fossil fuel consumed in New York City's buildings is especially worthy of study, not only because these buildings consume a substantial amount of energy, but also because of the special environmental and health issues arising from burning dirty heating oil in our study area – New York City's Upper West Side.

Heating Fuel 101

No. 6 oil is a residual fuel, which resembles tar or asphalt (as shown on the right below) and is the heaviest and most viscous of all fuel oils.

Figure 1. No. 2 (left) and No. 6 (right) Heating Oil Comparison. Source: http://www.edf.org/sites/default/files/10833_FAQ%202%20pager%20Feb%202010.pdf

No. 6 is a solid in its natural state and must be stored in a heated tank at approximately 100 degrees Fahrenheit to keep it in liquid form so that it can be pumped into the burner of a boiler.[xxi] When being pumped, the fuel must be further heated to approximately 150 to 200 degrees Fahrenheit. Because of these characteristics, residual fuels are generally only used in large boilers with heating capacity greater than 2.5 million Btu/hr.[xxii]

No. 1 through No. 4 fuel oils are considered distillate fuels. These fuels, which are liquid at room temperature, are less viscous and have lower energy content per gallon than residual fuels. They also have lower sulfur content and fewer contaminants.[xxiii] The heaviest of the distillate fuels is No. 4 oil, which is usually made in a 50/50 mix of residual No. 6 oil with No. 2 heating fuel. No. 4 oil has higher energy content than No. 2 oil, and is typically priced mid-way between the cost of No. 2 oil and No. 6 oil.[xxiv]

However, as of October 2012, No. 4 oil has to become low sulfur which means that a lot more No. 2 oil needs to be mixed in, bringing the price of low sulfur No. 4 oil very close to the price of No. 2 oil (Hess Oil is predicting the price difference to be less than 10 cents/gallon). In March 2012, No. 4 and No. 6 oil prices were actually *more* expensive than No. 2 oil prices.[6]

Although it is primarily more expensive, one benefit to burning No. 2 oil is that there is significantly less boiler maintenance required than when burning residual fuel. Distillate fuels do not need to be heated, nor do they require soot cleaning. This reduces the maintenance load to biannual or yearly cleaning. The maintenance cost savings relative to residual fuels at least partially offsets the increased fuel cost of distillate fuels.[xxv]

Another benefit with No. 2 heating oil is that a cleaner boiler generally increases efficiency and should lead to fewer gallons or at least the same number of gallons burned when switching to No. 2 oil despite No. 2 oil having less energy content (BTUs) per gallon compared to No. 6 oil.[xxvi]

[6] From discussion with Isabelle Silverman – attorney at Environmental Defense Fund. Although she is unsure as to why price of No. 2 dropped below No. 4 or No. 6, it was a short-term market action that goes to show the volatility that these types of markets can exhibit. Understanding this volatility is key to understanding how heating fuel oil and natural gas will factor into building's energy choices over the next 20 years.

An alternative to oil-based heating fuels is natural gas. Natural gas is a gaseous fossil fuel primarily composed of methane, but it also includes small amounts of carbon dioxide, nitrogen, helium and hydrogen sulfide.[xxvii] Natural gas is a cleaner burning fossil fuel than coal or oil that has great benefits for air quality. However, natural gas, like other fossil fuels, is a finite resource that comes with its own set environmental issues when extracted, such as the potential of water quality degradation. Thus, although using natural gas in the long term is unsustainable, it plays an important role as an interim fuel until we can power and heat buildings with alternative fuels.

Effect on Health and the Environment

Dirty heating oil, such as No. 6 oil, has caused environmental problems that directly affect people's health and daily lives. By using dirty heating oil, residential, commercial and institutional heating systems release 50% more fine particulate matter ($PM_{2.5}$) and 17 times more SO_2 than all vehicles on New York City's roads. The 8,813 No. 6 and No. 4 oil-burning buildings in the city – which represent 1% of the city's buildings – contribute 86% of the city's heating oil soot pollution. According to the U.S. Environmental Protection Agency (EPA), in 2002, residential, commercial and institutional heating systems in New York City alone released more than 30,000 tons of nitrogen oxides (NO_x), over 17,000 tons of sulfur dioxide (SO_2) and over 1,100 tons of soot or fine particulate matter ($PM_{2.5}$) into the atmosphere[xxviii].

Heating systems that burn dirty heating oil (No. 4 or No. 6 oil) also release heavy metals such as nickel into the air. Not surprisingly, New York City's nickel levels are on average nine times higher than in other U.S. cities. Nickel is a metal that when airborne has been linked to cardiovascular disease and premature death. Moreover, New York City has twice the national asthma hospitalization rate among children age 0-14 years. Over 300,000 New York City children have been diagnosed with asthma. This comes at a high cost, as asthma hospitalizations cost over $240 million a year. The maps below show how some of the neighborhoods with the highest asthma hospitalization rates also have many buildings that burn the dirtiest heating oil (No. 4 or No. 6 oil), exacerbating air quality in these neighborhoods[xxix].

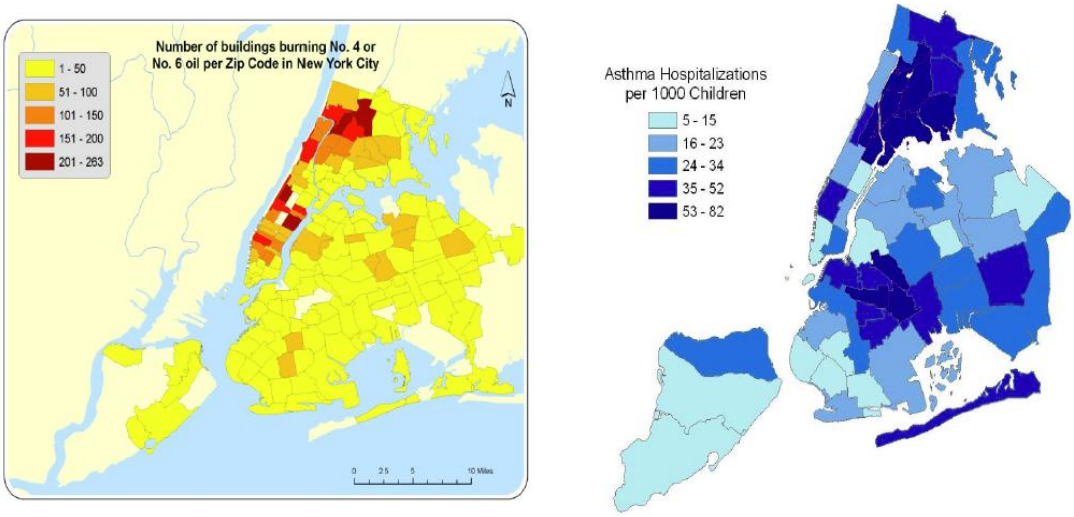


Figure 2. Concentration of buildings burning No. 4 and No. 6 oil by ZIP codes and asthma hospitalizations per 1000 children by neighborhoods

Therefore, our study will examine the following:

- Fuel conversion to replace dirty heating oil and control environmental pollution
- Energy efficiency upgrades to save energy and mitigate climate change

Urban Heat Island Effect

The term 'heat island' refers to built-up urban areas that are hotter than nearby rural areas. The difference in annual mean air temperature can be as high as 2-6 degrees Fahrenheit, depending on the size, density and population of the city[xxx]. The main reason for this difference is the presence of heat-absorbing roofs and other paved surfaces in urban areas. On a hot summer day, these surfaces can be 49-90 degrees Fahrenheit hotter than the air whereas moist or shaded surfaces in rural areas stay at the same temperature as the air. Elevated temperatures due to the urban heat island effect, especially during the summer, have many negative impacts on an urban community's environment and quality of life. These negative impacts include increases energy consumption, increased emissions of air pollutants and greenhouse gases, compromised human health and comfort and impaired water quality.[xxxi]

Increased Energy Consumption: Electricity demand for cooling increases 1.5–2.0% for every 1°F (0.6°C) increase in air temperatures, starting from 68 to 77°F (20 to 25°C), suggesting that 5–10% of community-wide demand for electricity is used to compensate for the heat island effect.[xxxii] Urban heat islands increase overall electricity demand, as well as peak demand, which generally occurs on hot summer weekday afternoons, when offices and homes are running cooling systems, lights, and appliances. By increasing energy bills, the urban heat island effect inflicts a direct cost on residents of urban communities. During extreme heat events, which are exacerbated by urban heat islands, the resulting demand for cooling can overload systems and require a utility to institute controlled, rolling brownouts or blackouts to avoid power outages.

Increased emissions of air pollutants and greenhouse gases: The reliance of electricity generation on fossil fuel based power plants means that increased demand for electricity due to the urban heat island effect leads to an increase in air pollutants and greenhouse gases. These air pollutants include sulfur dioxide, nitrogen oxides, particulate matter, carbon monoxide and mercury. These pollutants have negative health effects and contribute to air quality problems such as the formation of ground-level ozone, fine particulate matter and acid rain. The elevated temperatures due to the urban heat island effect also directly speed up the rate of ground-level ozone formation. Ground-level ozone is formed when NO_x and volatile organic compounds (VOCs) react in the presence of sunlight and hot temperatures. If all other variables are equal, such as the level of precursor emissions in the air and wind speed and direction, more ground-level ozone will form as the environment becomes sunnier and hotter. The increased demand for energy also leads to increased emissions of greenhouse gases which contribute to global climate change.

Compromised human health and comfort: Increased daytime temperatures, reduced nighttime cooling, and higher air pollution levels associated with urban heat islands can affect human health by contributing to general discomfort, respiratory difficulties, heat cramps and exhaustion, non-fatal heat stroke, and heat-related mortality. Heat islands can also exacerbate the impact of heat waves, which are particularly dangerous for sensitive segments of the population including children and the elderly. The Centers for Disease Control and Prevention estimates that from 1979–2003, excessive heat exposure contributed to more than 8,000 premature deaths in the United States.[xxxiii]

Impaired water quality: The fact that such a large percentage of an urban city's surface is impervious has serious implications for urban storm water runoff and water quality. Runoff from a rainstorm can quickly overburden an urban sewer system, especially a combined one that captures sanitary waste as well as storm water. Curbs, gutters, pipes, and gullies all direct the runoff to the same sewer system and outlets. Runoff can overload sewers, cause floods, and prevent the replenishing of local aquifers. Untreated runoff also carries nonpoint-source pollutants—such as sediment, nutrients, oil, and grease—into sewer and water treatment systems. The heat island effect adds another problem by heating up storm water runoff through contact with hot pavements and rooftops. Tests have shown that pavements that are 100ºF (38°C) can elevate initial rainwater temperature from roughly 70ºF (21ºC) to over 95ºF (35ºC).[xxxiv] This heated storm water raises water temperatures as it runs into streams, lakes, ponds and rivers and this can have serious implications for aquatic ecology. Rapid temperature changes in aquatic ecosystems resulting from warm storm water runoff can be particularly stressful, even fatal to aquatic life.[xxxv]

Background on Upper West Side

Upper West Side Apartment Building History and Neighborhood Description

The Upper West Side consists of the area enclosed by the zip codes 10023, 10024, and 10025. These boundaries are approximately from West 59th St to West 116th St and from Central Park West to the Hudson River. According to the US Census, there are 214,881 residents on the UWS living in a dense area of 83,000 people per square mile. As a result, the vast majority of residents live in multi-family buildings. Of the 124,708 housing units, 98% of housing units on the UWS exist in buildings with more than 5 units, 79% in buildings with 20 or more units, and 58% in large 50+ unit buildings[xxxvi]. Of these units, 69% are rentals while the other 31% are owner-occupied (counting condominium and housing cooperative units)[xxxvii]. These units average 1.72 residents per unit.

Figure 3. Map of the research area.

The UWS is an affluent neighborhood, as evidenced by its resident's incomes and real estate prices. The average annual household incomes for zip codes 10023, 10024, and 10025 are $131,000, $139,000, and $79,000

respectively[xxxviii]. The median home sale is over $1M[xxxix] and the current median rent per unit is over $2,900 per month[xl].

The building stock is generally categorized as either pre-war or post-war. This division is a result of the construction style within those periods. Pre-war buildings are those constructed before World War II. Usually between 10 and 20 stories, they are known for quality artistic craftsmanship and attention to detail. Many pre-war buildings incorporate hardwood strip or inlaid parquet floors, thick plaster walls that provide good insulation, and nine or ten foot ceilings.[xli] Any building constructed from World War II through to the 1970s is referred to as a post-war building. Post-war buildings generally have standard eight-foot ceilings, walls constructed of sheetrock, and large windows.[xlii]

Figure 4. New York City apartment buildings. Left, an example of post-war building. Right, an example of a pre-war building. Source left: http://propertymg.com/587-riverside-drive/. Source right: http://www.cpexecutive.com/regions/northeast/prewar-park-avenue-apartment-building-sells-for-253m-to-harry-macklowe/

More recently, more efficient buildings entered the building stock in New York City, though they make up a small percentage of all buildings. New York City has 204 LEED (Leadership in Energy and Environmental Design)-certified buildings, not including LEED-H (Homes) certifications.[xliii] There are 23 residential buildings that have obtained LEED-H certification in Manhattan.[xliv] In addition to the number of already certified buildings, many more LEED projects are underway in New York City. As of October 2011, New York City was ranked number one by United States Green Building Council for total number of LEED projects, including the 659 registered (but not yet certified) projects.[xlv] However, these modern buildings are dwarfed by the stock of older existing buildings. Thus, it is highly important to address methods for retrofitting older buildings since the stock of buildings will change slowly over time.

Carbon Footprint and Energy Consumption in the Upper West Side

New York City's high population density and extensive public transit system contribute to the city having one of the lowest per capita carbon emission levels among major global cities. Nonetheless, urban areas are estimated to be the source of approximately 70% of global greenhouse gas emissions (GHG) emissions.[xlvi] Being situated on the coast, New York City is particularly susceptible to the effects of climate change resulting from these emissions.

Electricity consumption is one indicator of energy use and carbon dioxide emissions of a building. Despite low per capita electricity use, driven largely by the fact that many New Yorkers live in apartment buildings and have smaller homes than the average American, approximately 75% of New York City's carbon emissions stem from

the energy used in buildings.[xlviixlviii] The electricity, heating, and hot water consumed in these buildings add up to $15 billion per year in energy costs.[xlix]

The 1% of New York City buildings that burn residual fuel also contributes 7% of all CO_2 emissions from New York City buildings. In 2010, 31% of the citywide CO_2e emissions came from large residential buildings.[lli] Figure 2 provides an illustration of how buildings and dirty heating oil are responsible for the harmful emissions of New York City.

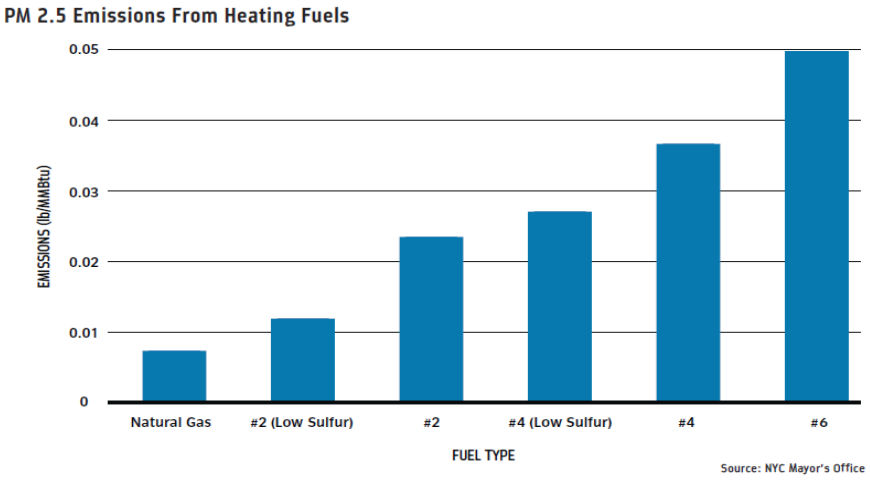


Figure 5. PM 2.5 Emissions from Heating Fuel. Source NYC Mayor's Office.

Energy Efficiency

The U.S. government estimates that an 80% reduction in GHG will be needed by 2050 to prevent catastrophic effects of climate change[lii]. Two major ways to reduce energy consumption and GHG emissions are to implement energy efficiency upgrades and develop alternative energy. Considering the average year built of buildings in our study sample is 1924, these buildings are energy-inefficient and thus there is a great potential for energy efficiency improvement on UWS.

The International Energy Agency conservatively estimates that energy use could be cut by one third by implementing simple energy efficiency methods.[liii] Efficiency improvements also save a large amount of money along with reducing greenhouse gases emissions.[liv] Every year, the U.S. commercial sector pays $108 billion for building energy bills, with over 75% spent on electricity.[lv] According to Flex Your Power, a 50,000-square-foot office building of average operating efficiency can reduce cost by $40,000 per year just through no-cost and low-cost efficiency upgrades.[lvi] Energy efficiency improvements increase building appraisals for building owners. Asset value typically rises by an estimated $3 for every $1 invested in energy efficiency.[lvii] A CoStar Group study found that Energy Star certified buildings sell for an average of $61 per square foot more than their peers, and LEED certified buildings sell for $171 per square foot more than uncertified buildings[lviii].

Traditional energy efficiency upgrades mainly include retrofits on lighting, appliances, metering, heating, ventilating and air-conditioning, cogeneration power systems, and building envelopes including roofs and insulation materials, etc. This report will discuss the situations to apply most of these upgrade methods to the buildings within the study area.

Regulatory Climate

PlaNYC

Figure 6. Cover from PlaNYC report.

Today's environmental regulations, initiatives, and city-wide plans for New York City fall under a large and unprecedented endeavor called PlaNYC. A collective effort of over 25 city-wide agencies, PlaNYC is the long-term environmental plan for New York City, aiming to build a greener city with lower carbon emissions by 2030. PlaNYC is Mayor Bloomberg's commitment toward helping "prepare the city for one million more residents, strengthen our economy, combat climate change, and enhance the quality of life for all New Yorkers."[lix] A product of efforts coordinated by the New York City's Office of Long-Term Planning and Sustainability (OLTPS), PlaNYC was released by Mayor Bloomberg in 2007 and was updated in early 2011.

Thus far, the plan seems to be working. According to NYC.gov, New York City has reduced its greenhouse gas emissions by 13% below its 2005 levels, launched over 97% of their original 127 initiatives, and achieved or mostly achieved almost 2/3 of its 2009 milestones. For example, the first official climate change projection for NYC was released in early 2009, the NYPD unveiled its first hybrid car on April 22, 2009, and as of the end of 2010 over one million square feet of NYC rooftops have been coated white (cool roofs).

Following the 2011 updates, PlaNYC now has 132 initiatives and more than 400 specific milestones in place to be achieved by December 31, 2013.[lx] Those 132 initiatives fall under at least one of the following ten categories: Housing and Neighborhoods, Parks and Public Space, Brownfields, Waterways, Water Supply, Transportation, Energy, Air Quality, Solid Waste, and Climate Change. For the purpose of the this study, we will be highlighting those initiatives and regulations set forth by the plan in both the Energy and Air Quality sections, particularly relating to the heating sources of large residential buildings as well as any other energy efficiency measures.

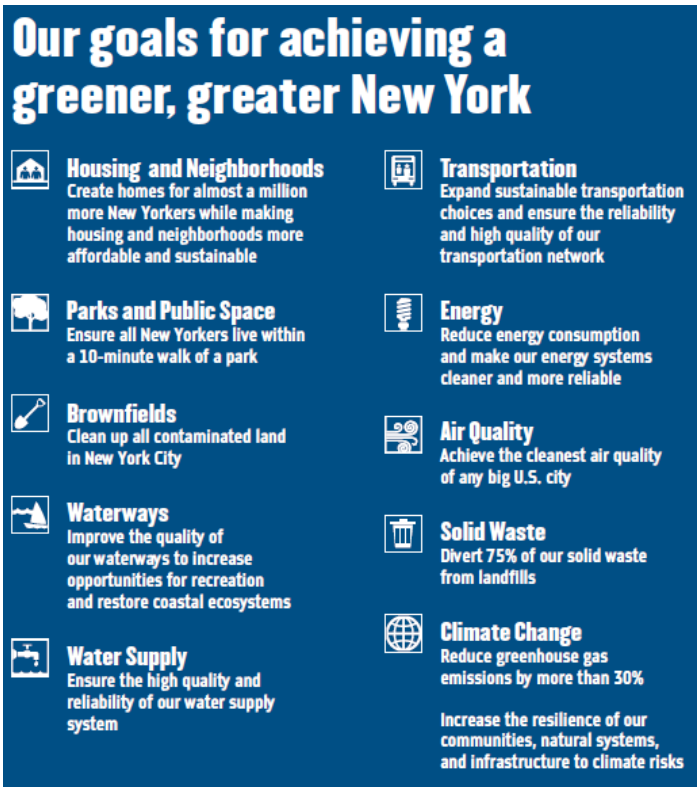


Figure 7. Summary of goals from PlaNYC report.

Greener, Greater Buildings Plan

Although PlaNYC is the overarching long-term environmental plan for New York City, the Mayor's office has made a direct commitment to addressing energy efficiency in the city's existing building stock, both private and public sector buildings. This set of laws, entitled the Greener, Greater Building Plan, was signed by Mayor Bloomberg in December of 2009, and according to City Government will accomplish the following tasks[lxi]:

- Remove loopholes in local energy codes to ensure that the law applies to all construction projects.
- Mandate cost-effective energy efficiency upgrades and evaluations of the largest public and private buildings in New York City.
- Serve as the most comprehensive set of energy efficiency laws in the United States.

Within the plan are the following four laws:

- *New York City Energy Code Local Law 85*[lxii]*:*
  - Establishment of new energy-efficiency standards under the New York City Energy Conservation Code (NYCECC) for new construction and alterations to existing buildings.
  - All new building and alteration applications filed after July 1, 2010 must comply with new NYCECC.
- *Benchmarking – Local Law 84*[lxiii]*:*
  - Energy and water use of buildings should be benchmarked for the previous calendar year.
- *Energy Audits and Retro-commissioning – Local Law 87*[lxiv]*:*
  - Requires energy audits and retro-commissioning of qualified buildings in order to garner detailed analysis of building's energy use and overall performance.
- *Lighting Upgrades and Sub-Metering – Local Law 88*[lxv]*:*
  - Mandates lighting system upgrade and installation of sub-meters in qualified buildings by 2030.

The mayor's offices believes that the Greener, Greater Buildings Plan will achieve an overall emissions reduction of 5% as it works to limit energy use and better air quality on 16,000 of the city's largest properties, which together represent about 45% of the city's greenhouse gas emissions.[lxvi] Furthermore, the plan will decrease energy costs annually by an estimated $700 million by 2030, as well as create about 17,800 construction related jobs over the next 10 years.[lxvii]

At its core, the Greener, Greater Buildings Plan will serve as the superseding energy code for New York City in buildings that undergo renovation, repair, or new construction. The code will mandate that all buildings noted here[7] (based on square footage of property, updated list is being generated for 2012 – if your building is covered, you will have received a letter of compliance from the NYC Department of Finance in 2011) will be required to benchmark energy use, conduct audits and retro-commissioning of the building, and begin the conversion to both better lighting and sub-metering.

The details of the mandated energy performance activities are located at NYC.gov, and will help direct building owners toward the following: information on benchmarking, how to conduct or contract a benchmark for a building, how to receive training about the energy code, how to schedule energy auditors and retro-commissioners, and where to receive possible financing and incentives. Lastly, the City Government and Urban

[7] Visit http://www.nyc.gov/html/planyc2030/downloads/pdf/120210_benchmarking_compliance_list02-10-12.pdf to determine if your building is covered under the Greener, Greater Buildings Plan.

Green Council offer free presentations[8] that provide a holistic overview of the new laws, while also providing a plan for those buildings over 50,000 square feet, which applies to every building in the area of study in this report.

In addition, organizations such as Bright Power Inc.[9] provide services that help buildings understand and address the various mandates under GGBP. Bright Power Inc., founded in 2004, specializes in the analysis of energy use in multi-family buildings, and is focused on helping large residential buildings in New York City comply with Local Laws 84 and 87 – mandatory benchmarking, retro-commissioning, and energy auditing. By utilizing advanced but customer-friendly software, such as their EnergyScoreCards, important information and recommendations can be developed for both individual buildings and building portfolios.

Figure 8 below shows an example of a real EnergyScoreCard that was generously provided for this report from Bright Power Inc. As seen in the upper left hand corner, this EnergyScoreCard is that of a 338 unit multi-family residential building that is located within our area of study (building address is anonymous). The acronym '(T) TOO' refers to the payment structure for this building, which in this case follows the traditional NYC set-up of tenants paying for cooling and electric, and the owner paying for heating and hot water. The 'EOO' refers to the type of fuel used in the building, which in this case translates to electricity as the input for the building's cooling, and oil as the fuel choice for the building's heating and hot water.

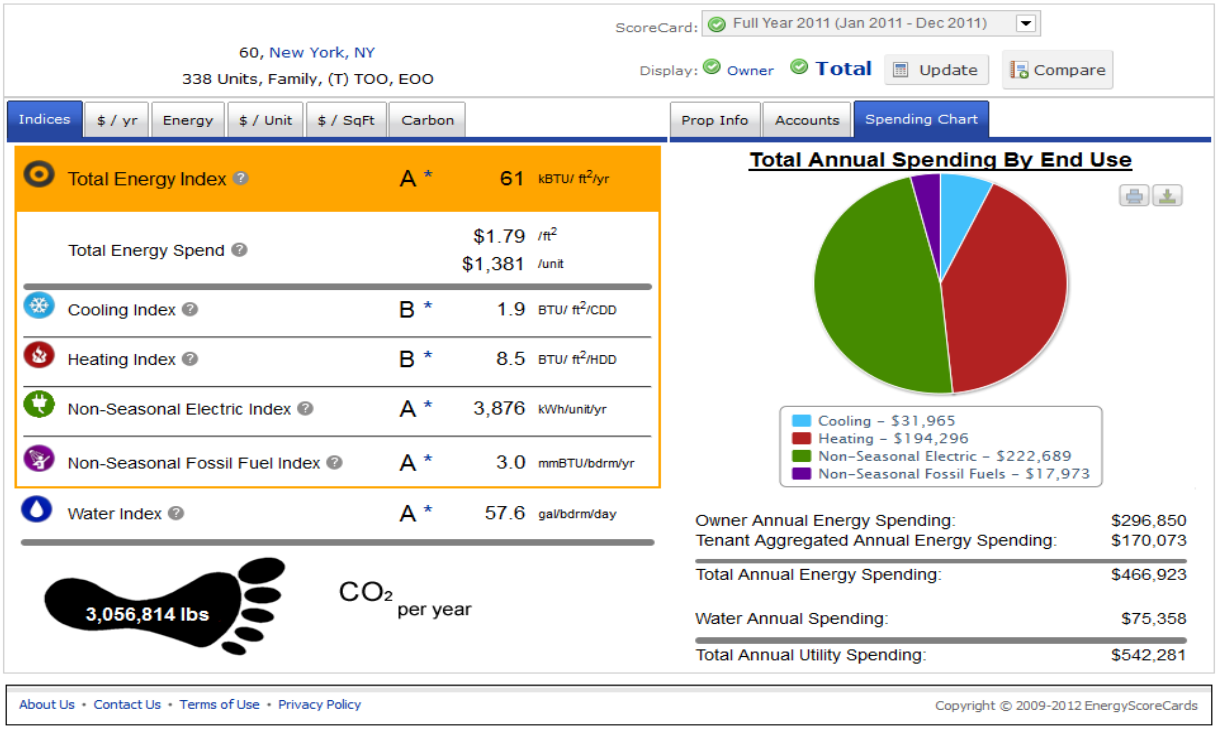


Figure 8 - Example of the EnergyScoreCard (provided by Phil Vos of Bright Power Inc.)

The listed indices and respective letter grades refer to how well the building performed in 2011 (noted in top right) in those specific areas, compared to buildings of similar characteristics (size, location, climate, etc.). The cooling index corresponds to energy consumption during the cooling months (summer), while the heating index

[8] More information on how to receive a free presentation can be found at http://www.urbangreencouncil.org/education/ggbp-education/.
[9] More information on Bright Power Inc. can be found here.

refers to energy consumption during the heating months (winter). The non-seasonal electric and fossil fuel indices correspond to year-round non-cooling unit electricity consumption (TVs, toasters, etc.) and hot water consumption respectively. An initial analysis of this building shows that while the building overall is performing very-well in terms of its energy use, it is under-performing in its heating and cooling services. As the pie chart on the right side of the chart illustrates, heating and cooling are responsible for nearly 50% of the total energy-related expenditures for the building, and thus hold room for improvement – perhaps in the conversion of the boiler. And because this building is reliant on oil as the source for its heating, it is a very relevant example to the analysis and subsequent recommendations seen in this report.

Furthermore, the year-round electricity consumption of the building represents nearly the other 50% of the building's energy-related expenditures. This provides an ample opportunity for improvement that could be addressed and solved through the implementation of energy efficiency measures that are analyzed and recommended throughout this report.

Overall, organizations like Bright Power Inc. will play a major role in helping the city's building stock adapt to the new regulations under PlaNYC, and it is the opinion of the authors that Upper West Side buildings collaborate with these types of organizations if they are unsure about next steps and what options are actually available to them.

Ban on No. 6 Heating Oil

The most important and relevant initiative of PlaNYC for this report is Initiative 8, which discusses the conversion of heating fuels for the building stock of New York City. This initiative is the primary driver for the shift in heating fuels in New York City over the next 20 years.

Through Initiative 8, the Mayor's Office is committed to ridding No. 4 and No. 6 oil from the 8,813 buildings that currently burn them. The Department of Environmental Protection (DEP) and Department of Buildings (DOB) in May of 2011 began implementing a program designed to phase out No. 4 and No. 6 oil from buildings. The regulations, passed in 2010 and adopted in April of 2011, began enforcement on May 23, 2011 following release of the approval process by the DEP and DOB. PlaNYC aims to partner leaders of the change with building managers and utilities to help foster quick implementation of the new regulations. While the ultimate goal is to change the heating source of large residential buildings that burn dirty oil to a cleaner source, PlaNYC will also initially focus on assisting New York City schools on the conversion to cleaner fuels. According to the PlaNYC, 415 schools (about 1/3 of all NYC schools) burn either No. 4 or No. 6 oils.[lxviii] Health benefits will follow a conversion of fuels, as well as monetary savings and a reduced carbon footprint.

According to the DEP and DOB, the implementation of the phase-out of No. 4 and No. 6 oils will occur in several parts[lxix]:

1. As of **May 23, 2011**, any newly-installed boilers will be required to only burn No. 2 heating oil, natural gas, or the equivalent from an emissions standpoint.
2. Starting on **July 1, 2012** upon expiration of a building's DEP boiler permit, the building will be required to switch from No. 6 oil to at least the new low sulfur No. 4 heating oil or to an equivalent cleaner fuel such as No. 2 heating oil or natural gas.
3. By **July 1, 2015**, all No. 6 oil buildings will have to have converted to a cleaner fuel unless they were given an extension by the DEP.

4. As of **May 23, 2011**, all No. 4 oil buildings will need to switch to No. 2 oil or natural gas upon boiler or burner replacement.
5. As of **October 1, 2012** all No. 4 oil buildings must switch to cleaner low sulfur No. 4 oil which does not require any equipment adjustments.
6. By **2030**, all No. 4 oil buildings must switch to low sulfur No. 2 oil, natural gas or an equivalent cleaner fuel.

It is important to note that these regulations come on the heels of additional state laws that resulted from initiatives in the PlaNYC. In early 2010 it was mandated by the City Council that sulfur content in No. 2 had to be reduced by 2012, and in August of 2010 low-sulfur No. 4 heating oil was mandated through Local Law 43.

Additional PlaNYC Initiatives – Energy

Within the Energy section of the PlaNYC, OLTPS has identified 17 different initiatives that aim to address the city's energy challenges, many of which directly pertain to residential buildings and issues pertinent to this report. A list and short description of 5 of these initiatives can be found in Appendix F.

Stakeholder Analysis

Building Management Structures and Incentives

Residential buildings on the Upper West Side in New York fall under various management and ownership structures, but can be basically divided into rental, condominium, and housing cooperative buildings. These management structures affect the barriers and incentives for changes and upgrades within a building. Although our analysis specifically targets housing cooperatives, it is important to distinguish the advantages and disadvantages of a cooperative structure compared to other management types.

Rental

Rental buildings are fully owned by a landlord and managed by the same entity or another management company. Within a rental building, residents do not own any part of their units and simply pay rent to live in their unit. Without ownership, residents are limited by the rules stipulated in their leases as to what improvements they can make to their apartments. Ultimate control lies with the landlord to approve upgrades throughout the building, though tenants have rights enumerated by the state Rent Guidelines Board, which requires landlords to maintain adequate conditions or provide upgrades[lxx].

Depending on the building, rent may include utilities or the utilities may be passed to the tenant. This will greatly determine the incentives for landlords to make improvements. If the lease is structured such that tenants pay the utilities, landlords will be unlikely to invest much in making efficiency improvements, beyond what is needed to maintain higher rents, to stay competitive, and to meet regulatory standards. Additionally, if tenants are directly paying for their utilities, they will not be encouraged to invest in upgrades if the payback periods are longer than the length of their lease. If tenants are signing leases year-to-year, they will not have the time horizon necessary to invest in efficiency upgrades. Ultimately, upgrades to a rental building will have to be proposed by the landlord.

One solution to enable these upgrades is to simply raise rents and pass the cost of these improvements to the tenants. However, there are often limitations preventing landlords from employing this tactic through both city and state regulation. This is particularly an issue with buildings that are rent controlled and rent stabilized. There are about 40,000 apartments in New York City that fall under rent control and 1 million apartments that are rent-stabilized[lxxi]. Thus landlords may not be able to fully pass on their costs by increasing the rent by the required amount. As a result, landlords may refrain from major improvements.

Thus, rental buildings suffer from the "principle-agent" problem in that self-interest does not line up with energy efficiency, unless the costs and benefits of an energy efficiency upgrade can flow through the landlord.

Condominium

Condominiums (condos) are usually associated with more modern buildings. Condominium laws developed in the US in the 1960's as individual states passed laws. New York State passed its own condominium law in 1964.[lxxii] Condominium laws served as a solution to provide a means for physical home ownership within multiunit apartment buildings.

Within this structure, building tenants own their individual housing units. The boundary of these housing units is defined in a Declaration[lxxiii], which ultimately decides where tenants can make alterations. Outside of the

housing unit boundaries, all common areas are owned by a corporation founded at the building's creation that holds those areas in trust on behalf of the homeowners. Tenants then form a homeowners association (HOA) to represent the interest of all occupants, whereby members elect a board of directors from their membership to work on behalf of the trust[lxxiv]. The HOA then can make decisions on maintenance and upgrades to the common areas of the property. In order to maintain these common spaces, HOA members pay monthly member dues that will cover operating expenses and periodic capital improvements[lxxv], although there may be special, one-time assessments to pay for upgrades beyond regular maintenance.

When making upgrades to condominium buildings, the HOA can only make decisions on the common spaces and surfaces and not within individual apartments. Thus, if there is an upgrade that can save money in the common spaces, with enough education, an HOA will vote for it. However, an HOA has limited authority over individual apartments. However, since residents own their units and pay their own utilities, they will be encouraged to improve their own unit's efficiency if they are educated about their options, but change will occur on a unit-to-unit basis.

Housing Cooperative

Before condominium laws swept through the U.S., housing cooperatives (co-ops) were popular for new large apartment buildings and common for large luxury buildings built before condominium laws. New York City had its first housing cooperative built in 1876[lxxvi]. Before condominium laws, co-ops allowed for tenants to have an ownership stake in a multiunit building, but not direct ownership of their individual housing units.

Co-ops differ from condos in that tenants do not own their units. Instead the co-op is a legal entity that owns the building and tenants own shares in the building proportional to the square footage and location of the apartment within the building (i.e. higher floors have more shares). Since tenants do not physically own their units, the co-op can enact more control over individual units, enumerating rules for occupation and for consistent standards[lxxvii]. These standards can be anything from wall paint color, carpet-to-floor ratio, to mandating energy efficient appliances. Thus, should a tenant want to make an alteration to their unit, they must clear it with the co-op board such that it is up to the standard.

Much like an HOA, co-ops have a board consisting of elected members from the building's tenants that can make decisions on behalf of the building, as defined by the co-op charter. In order to make substantial changes, all tenants vote whereby their voting power is proportional to the shares they hold[lxxviii].

In the co-op structure, the "principle-agent" problem is minimized since residents are both the tenant and owner. Compared to condominium HOAs, co-op boards are stronger entities that can enact change throughout a building and individual living units provided they can get the necessary votes from tenants. Like HOAs, co-ops are incentivized to save money and suppress common dues and thus will vote for efficiency measures to save money on common spaces. The co-op's authority can then enact changes in the co-op standards to increase overall efficiency in individual units. Again, education on options is the key in convincing these entities to accept energy efficiency upgrades. Since the co-op is a democratic structure, this education must spread to as many shareholders as possible if energy efficiency upgrades are to be adopted.

For our analysis we will only focus on co-op structure buildings, however most of our recommendations can be extrapolated to rental and condo buildings.

Stakeholders

The stakeholders involved in making energy efficiency improvements to apartment buildings are numerous. The most fundamental stakeholders are residents and building managers. However, a number of ancillary stakeholders play a role in facilitating energy efficiency upgrades.

In a co-op building, it is ultimately up to the co-op board to make decisions on capital expenditures on the behalf of tenants. When considering these expenditures, the board will consider three things:

- Will they improve the value of the building?
- Will they reduce maintenance costs?
- Will they produce a better quality of life for tenants?

A decision may involve one or more of these criteria. However, since not all of these boards contain real estate maintenance professionals, they will defer to the expertise of either the resident manager/superintendent, who handles day-to-day operations, or a building managing agency, which may manage one or many buildings, that will handle larger, one-time engineering projects. Like the co-op boards, management will encourage projects that will make the most "economic sense" while addressing the above questions. Residents and managers will try and find solutions that minimize short and long term costs and maximize quality of life and building value.

Other important players in capital expenditures on energy efficiency upgrades are governments, utilities, resource providers, and manufacturers, all of which have great influence on the decision of buildings. Governments, whether at the community, city, state, or federal level can impose regulations or introduce incentives to choose technologies or fuels that will be adopted by buildings that can either please or displease their constituents. Utilities also can incentivize adoption of energy efficiency technologies or alternate fuel that can ultimately lead to increased business performance. These incentives can include sending free CFL bulbs to making subsidized gas connections to buildings in exchange for locked-in demand. Resource providers (oil and gas marketers) want to expand their market share and make sure that buildings will choose to use their fuels. Manufacturers of energy efficiency technologies will want to expand their market for their goods and produce products that buildings will want to incorporate. These overlying market and regulatory stakeholders provide great sway over the decisions made between residents and building managers.

Lastly, there are several specialized stakeholders that include historic preservationists and environmental groups. Although energy efficiency upgrades may be important to preservationists, these upgrades cannot affect the historic nature of the building, which is a major concern for the many historical landmark buildings of the UWS. Large swaths of buildings on the UWS are located within designated historic districts and preservationists continue to request landmark status for more buildings in which some groups keep a database of almost 5,000 buildings that are either landmarked or can be landmarked[lxxixlxxx]. Environmental groups look to improve the quality of life through energy efficiency and fuel choice, which has effects on the area's air pollution and carbon footprint. These groups will lobby for government regulations, encourage industry incentives, or simply make their case directly to citizens.

Although the basic resident/management relationship is the most basic decision-making vehicle, the many layers of ancillary, invested stakeholders place pressure on that relationship to affect the decision-making process and ultimately factors into what energy efficiency upgrades will be adopted.

Fuel Conversion

It is the goal of this section to identify and discuss the effects of upgrading Upper West Side boilers that are currently burning No. 6 oil. For the purposes of this report, the conversion process from No. 6 oil can potentially culminate in one of the following three scenarios: burn solely No. 2 heating oil, a dual fuel burner with No. 2 heating oil and an interruptible natural gas rate (burning natural gas 75% of the time), and burning solely natural gas at the firm rate (more expensive than the interruptible rate).

Figure 9. Left, example of oil-fired boiler. Right, example of gas-fired boiler. From EDF, "Bottom of the Barrel."

Using basic financial and energy models that utilized data from the NYC Open Data catalog and EDF's "Bottom of the Barrel" report, we were able to calculate associated costs and reductions in pollution for each fuel conversion scenario.

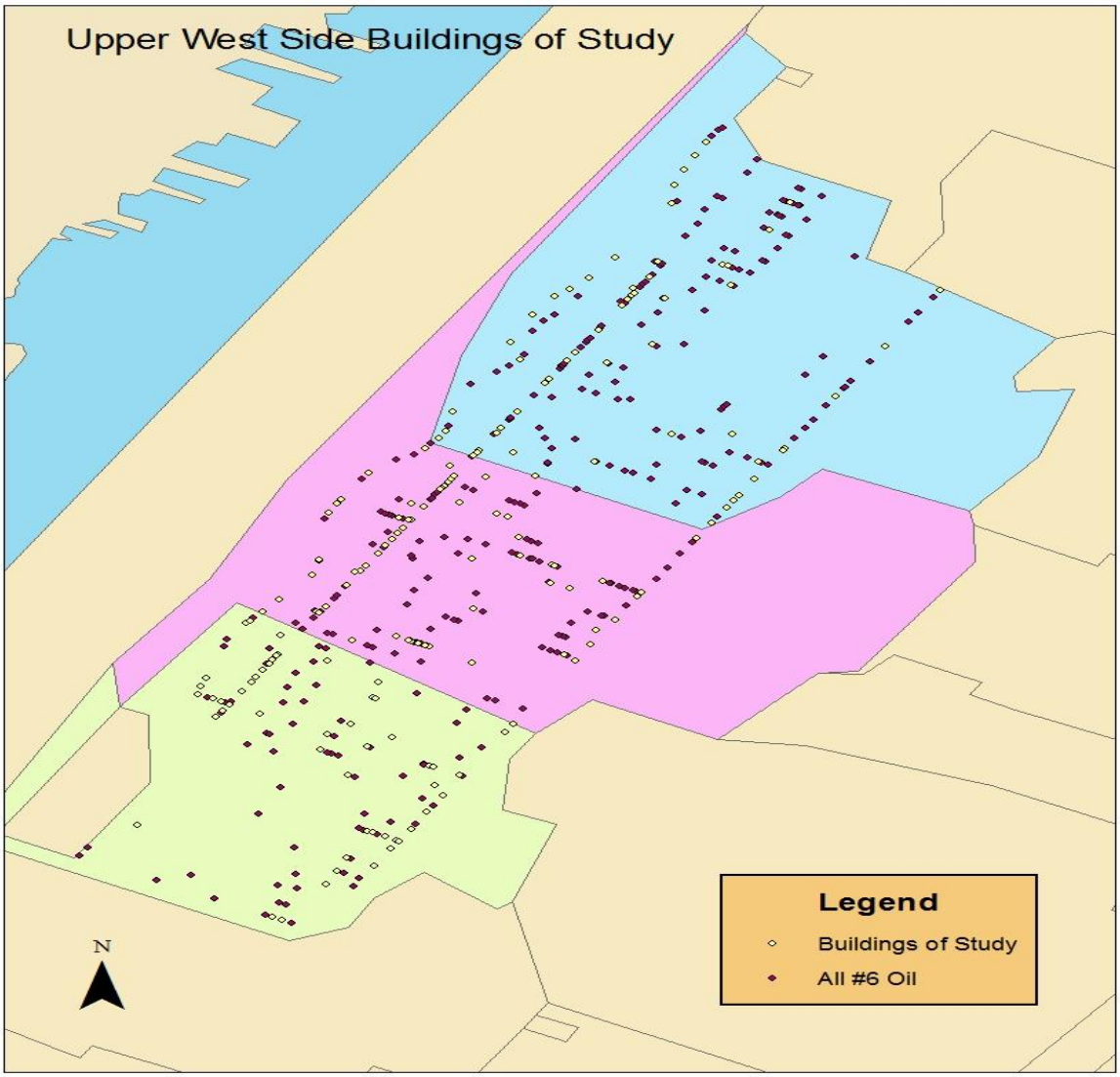
Please refer to Appendices B and C for a complete list of all 186 buildings that were used in our analysis. Important information regarding boiler performance, expiration of boiler permits, and expected retirement years of boilers are noted as well.

Analysis

The three fuel conversion scenarios were conducted using the average BTU consumption and average number of gallons of No. 6 oil burned in the 186 buildings and 225 boilers identified for our study. The characteristics for the chosen buildings and boilers, specified by BBNY, are listed below:

- Upper West Side (59th St. to 110th St.)
    - Zip Codes: 10023, 10024, 10025
- Equal to or greater than 30 residential units
- Residential buildings defined as follows: loft, elevator, walk-up, asylums and homes
- Co-Op ownership structure
- Primary fuel burned is No. 6

Figure 10: Map of Upper West Side Buildings of Study



An initial analysis of the 186 buildings and 225 boilers used in the fuel conversion study demonstrate the following characteristics, and are accompanied by corresponding graphs[10]:

- An average building size of 145,940 square footage
- An average number of 91 residential units per building
- Average year built - 1924
- 23% boilers due to retire before 2015
- 46% of all boiler permits will expire in either 2012 or 2013
- 64% of boilers were installed before 1990

[10] All data used in calculations for below graphs were made using data from "Oil Boilers – Detailed Fuel Consumption and Building Data" database.

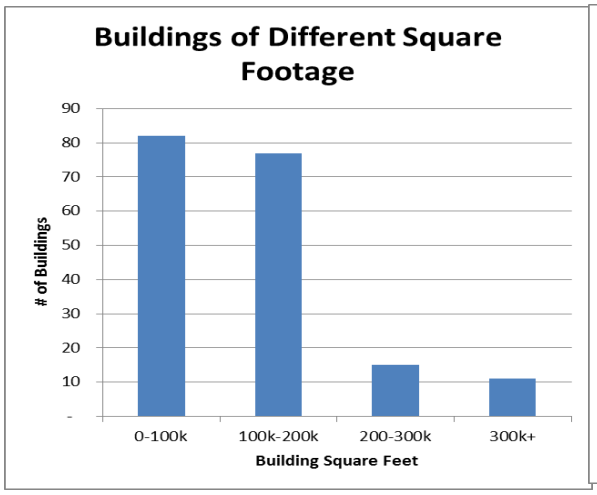


Figure 11. Chart of Buildings by Square Footage.

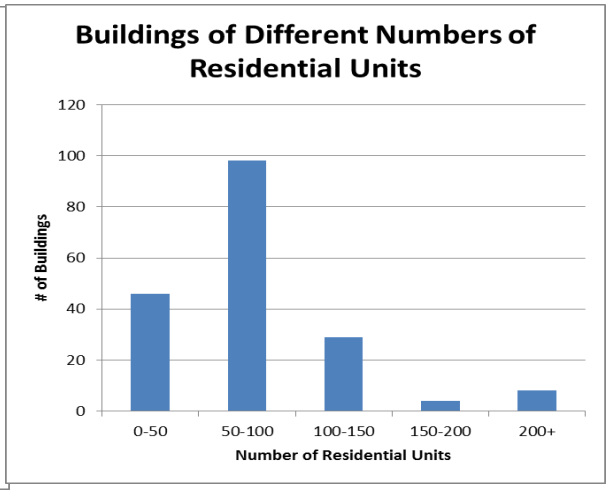


Figure 12. Chart of Buildings by Number of Residential Units

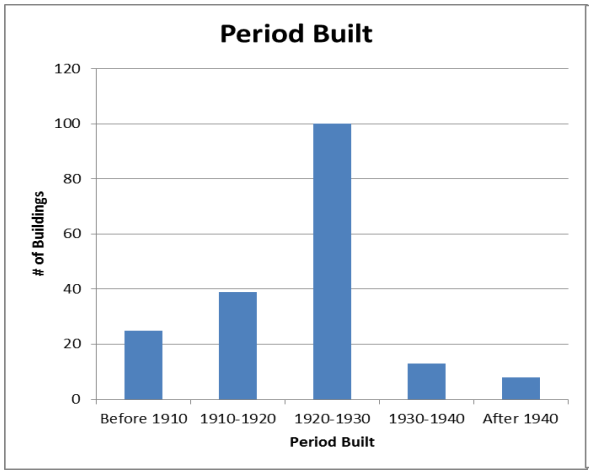


Figure 13. Chart of Boilers by Retirement Year.

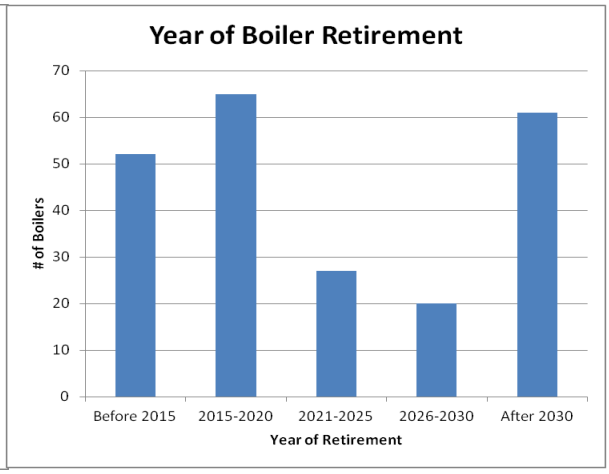


Figure 14. Chart of Buildings by Year Built.

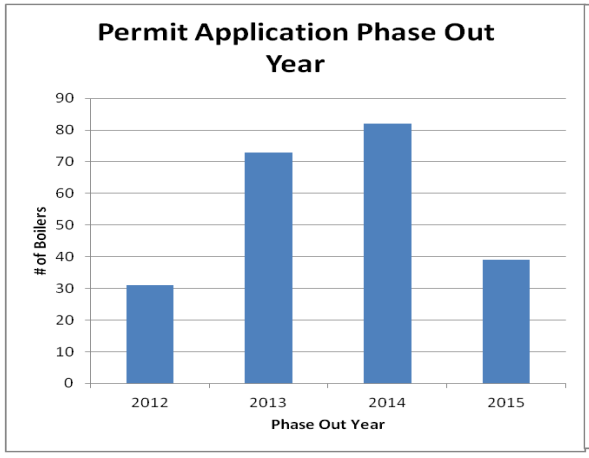


Figure 15. Chart of Boilers by Permit Application Phase Out Year.

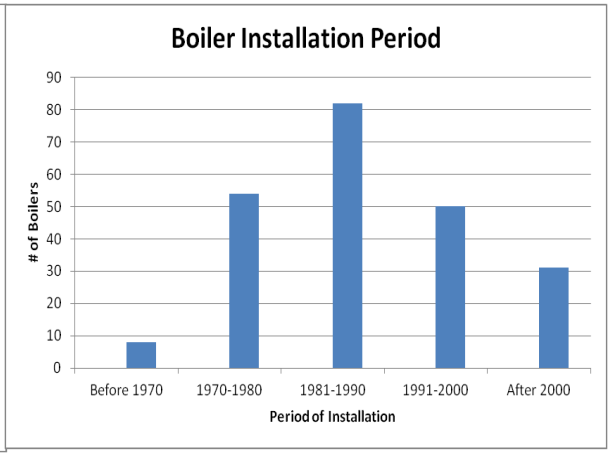


Figure 16. Chart of Boilers by Installation Period.

Other important characteristics of the buildings and boilers in our study include[11]:

- 69 of the 225 (30.7%) boilers currently have the capability to be a dual fuel burner (i.e. No. 2 and natural gas)
- The average annual mmBTU consumption of a site, defined as one building that may or may not have more than 1 boiler, is 13,040 mmBTU
    - The average site gross mmBTU/hour rate is 9.89
    - The average boiler mmBTU/hour rate is 8.18
- The average site needs 86,933 gallons of No. 6 heating oil on an annual basis
- All buildings in the study, as a group, annually consume on average 2,425,418 mmBTU and require 16,169,454 gallons of No. 6 heating oil

As part of PlaNYC, buildings are mandated to switch from No. 6 oil to No. 4 oil by 2015, and eventually to No. 2 oil or natural gas by 2030. A majority of the boilers in the study area will be facing a phase out of their permit application in the next few years, and thus now is the appropriate time to convert their fuel source in order to meet the 2015 mandated switch off of No. 6. Below are the models and analyses that illustrate the costs and benefits of the aforementioned three different fuel conversion scenarios.

Important Preface on Model Data and Assumptions

- The baseline annual average mmBTU consumption, average BTU consumption rate, and needed number of gallons of No. 6 oil were derived from analysis of the NYC Open Data database. These numbers represent the 'site' average, again defined as a building that may or may not have more than 1 boiler.
- Natural gas prices (interruptible and firm rate per therm) are prices given by the NYC Open Data database based on the average prices of Con Edison natural gas from 2008-2010. Con Edison is and would be the sole supplier of natural gas for all buildings in the area of study.
- Fuel prices for No. 6 and No. 2 oil are prices listed in EIA's 2012 Annual Energy Outlook. While the release date for the full report is not until the spring of 2012, EIA released certain tables, figures, and data on January 23, 2012. Data needed for this analysis was found in that pre-released data set.[lxxxi]
    - 2012-2025 average price of No. 6 oil - $2.53/gallon or $16.88/mmBTU
    - 2012-2025 average price of No. 2 oil - $3.50/gallon or $24.98/mmBTU
    - 2012-2025 average price of natural gas - $9.17/mmBTU
- Costs regarding the conversion process (capital upgrades, maintenance, etc.) are derived from both the NYC Open Data database and EDF's report "Bottom of the Barrel". Efforts were made to be conservative in regards to cost estimates.

All final calculations (i.e. total savings, pollution reduction) are to be interpreted on an annual basis for the average building in our area of study. Actual financial and emission savings will vary by building, but calculated numbers in our models should provide a good insight as to the potential of the three fuel conversion scenarios for an individual building.

[11] All data used in calculations for below graphs were made using data from "Oil Boilers – Detailed Fuel Consumption and Building Data" database.

Fuel Conversion Analyses

Switch from No. 6 to No. 2 Oil

Due to No. 2 oil's lower energy content, it will take 93,142 gallons of No. 2 oil to provide the same amount of energy as 86,933 gallons of No. 6 oil. However, the efficiency of boiler burning No. 2 oil is higher than that of No. 6 by about 2%, and can thus decrease the amount of gallons of No. 2 needed down to 91,279 gallons.[lxxxii] Furthermore, other efficiency measures[12] can save up to an additional 20%, again decreasing the amount of fuel needed, ultimately down to 73,023 gallons of No. 2 oil.[lxxxiii]

Capital costs of converting to No. 2 oil include new burners, removing the fuel pre-heater, cleaning the tank, and other minor technical changes. The model below assigns costs to each of these tasks, and identifies the operating costs with using either No. 6 oil or No. 2 oil.

Building Energy Characteristics (average building site for area of study):

- Annual Energy Consumption: 13,040 mmBTU
- Consumption Rate: 9.893 mmBTU/hour
- Amount of No.6 oil previously needed: 86,933 gallons

Conversion with upgrade of No. 2 boiler

Capital Costs (upgrade)		
Burners Tuning	$	12,275
Remove pre-heater/clean tank/other techincal changes	$	8,500
Operating Costs		
Annual #6 oil expenses	$	220,096
Annual Tank Heating	$	1,960
Annual Soot blowing/maintenance	$	5,000
Total	**$**	**227,056**
Proposed Operating Costs		
Annual #2 oil expenses	$	255,422
Boiler Maintenance	$	1,000
Total	**$**	**256,422**
Total Capital Costs	$	20,775
Annual Savings	$	(29,366)

Conversion with replacement of new No. 2 boiler

Capital Costs (replacement)		
New Burners	$	59,000
Retire Old Tank	$	4,250
New Tank	$	55,000
Operating Costs		
Annual #6 oil expenses	$	220,096
Annual Tank Heating	$	1,960
Annual Soot blowing/maintenance	$	5,000
Total	**$**	**227,056**
Proposed Operating Costs		
Annual #2 oil expenses	$	255,422
Boiler Maintenance	$	1,000
Total	**$**	**256,422**
Total Capital Costs	$	118,250
Annual Savings	$	(29,366)

Figure 17. Table of Conversion for No. 6 to No. 2 oil

[12] Other efficiency measures includes the following: regular maintenance of heating and hot water systems, regular boiler tube cleaning, yearly combustion efficiency tests, air/fuel ratio adjustment, maintenance of steam traps, air valves and shutoff valves on all radiators.

Cost References for Upgrade

- Boiler Tuning - $12,275[lxxxiv]
- Remove pre/heater/clean tank/other technical changes - $8,500[lxxxv]
- Annual soot blowing/maintenance - $5,000[lxxxvi]
- Boiler maintenance - $1,000[lxxxvii]

Cost references for replacement

- New burners - $59,000[lxxxviii]
- Retire old tank - $4,250[lxxxix]
- New tank - $55,000[xc]

As the tables display, even with higher boiler efficiency and the implementation of other efficiency measures, the difference in fuel costs make this conversion financially unattractive.

It is important to note that most burners that have been installed in the last 15 years (37 of such in the area of study) are readily convertible to No. 2 heating oil, and will thus be able to forego the additional costs listed in the table on the right, and will instead mirror the table on the left. This will lower the cost for the 37 boilers that were installed post-1997, but although capital costs are decreased, they will still be subject to the higher costs of burning No. 2 over No. 6 oil.

A main conclusion that can be drawn from this conversion scenario is that it will not be very capitally expensive to shift a building's boilers from No. 6 to No. 2 when mandated by the new laws under the GGBP. In time, however, the operating costs of the new boiler, due to both initially increased consumption and higher fuel costs, will have a detrimental effect on the building's heating expenses.

The result of converting from No. 6 to No. 2 is nearly identical to that of a No. 6 to No. 4 conversion. Although our team did not evaluate the No. 6 to No. 4 conversion scenario, buildings can comply with the 2015 GGBP mandate through that conversion. Our team was committed to identifying potential decisions that would allow UWS buildings to fully comply with all heating mandates of the GGBP, allowing them to make proper long-term decisions. Like No. 2 oil, No. 4 has a lower BTU content but a higher price than No. 6, and thus it is not financially advantageous to convert from No. 6 to No. 4, even with some of the aforementioned boiler efficiency upgrades.

Although the No. 6 to No. 2 conversion is not financially attractive, it does generate positive benefits in terms of reduced emissions. Figure 17 illustrates the annual amount of emissions that can be avoided by an average UWS building in our area of study with a conversion from No. 6 to No. 2 oil[xci].

Pollutant	Before Conversion (lbs)	After Conversion (lbs)	Savings (lbs)	% Reduction
PM (2.5)	519	29	490	94%
Nox	4,782	1,315	3,466	72%
SO2	4,094	1,037	3,057	75%
VOC	111	40	71	64%
CO	435	365	70	16%
CO2	2,173,748	1,628,567	545,182	25%

Figure 18. Table of Emissions Before and After Transition from No. 6 to No. 2 oil.

To help put these figures in context, the building's 94% reduction in particulate matter would be equivalent to taking 3,772 passengers cars off of the road.[xcii] Furthermore, the 72% reduction in NO_x would be equivalent to removing 138 passenger cars from the road, and the 25% reduction in CO_2 emissions would be equivalent to taking 56 cars off of the road.[xciiixciv] Lastly, the 75% reduction in SO_2 is equivalent to preventing the pollution of coal plants that stems from the annual generation of electricity for 70% of an average American household.[xcvxcvi]

Switch from #6 to Dual Fuel

When a building considers a conversion to a dual fuel burner, the financial and environmental benefits immediately become evident. At its core, a dual fuel burner is capable of burning both No. 2 oil and natural gas in order to heat the building. In moderate weather the building will employ natural gas and only during very cold temperatures will the No. 2 oil be burned, serving in a sense as a backup fuel.

This model is advantageous because buildings can receive a lower rate for natural gas, known as the interruptible rate. This gives the natural gas company, in this case Con Edison, the power to shut off supply to the building in order to fulfill higher demand in other places. Con Edison will compensate the building by providing a lower rate for their normal natural gas supply. This prevents Con Edison from encountering a short supply in critical situations, and also prevents the building from having to pay higher rates during a time when demand for natural gas is elevated.

The heating costs below are the EIA average of fuel costs from 2012-2025 and the natural gas cost is the 2008-2010 average of Con Edison's Interruptible Gas Rate for demand lower than 100,000 therms. In this model it is assumed that the building will burn natural gas 75% of the time and No. 2 oil 25% of a time, a ratio that is rather conservative according to EDF.[xcvii] As the building uses a higher ratio of natural gas to No. 2 oil, the financial and environmental benefits will in turn increase.

Building Energy Characteristics (average building site for area of study):

- Annual Energy Consumption: 13,040 mmBTU
- Consumption Rate: 9.893 mmBTU/hour
- Amount of No.6 oil previously needed: 86,933 gallons

Costs		
Dual fuel burner	$	20,000
Tank cleaning	$	3,000
Secure/remove fuel heating equipment	$	2,000
Chimney cleaning	$	50,000
Gas Booster	$	25,000
Natural Gas Piping	$	18,500
Condensate Pumps	$	1,000
Operating Costs		
Annual #6 oil expenses	$	220,096
Annual Tank Heating	$	1,960
Annual Soot blowing/maintenance	$	5,000
Total	**$**	**227,056**
New Operating Costs		
Annual #2 Oil expenses	$	81,448
Annual NG expenses	$	99,698
Annual Maintenance	$	1,000
Total	**$**	**182,147**
Total Capital Costs	$	119,500
Annual Savings	$	44,910
Payback Period (Years)		2.66

Figure 19. Table of Conversion for No. 6 to Dual Fuel.

Cost References

- Dual fuel burner, tank cleaning, secure/remove fuel heating equipment, and condensate pumps[xcviii]
- Chimney cleaning, gas booster, natural gas piping[xcix]
- Annual tank heating, annual soot blowing and maintenance[c]
- Annual maintenance[ci]

As the model illustrates, an $119,500 capital investment is covered rather quickly by the significant decrease in both heating fuel expenses and the annual maintenance of the boiler. A 2.7 year payback for such an investment is quite promising and can achieve many goals in a very short period of time, including the following:

- Ability to successfully meet the new heating fuel mandates under PlaNYC
- Decrease annual heating expenses
- Significant reduction of harmful pollutants (specifically particulate matter/soot)

A crucial caveat to the above model is that a single building may not be able to persuade Con Edison to install natural gas infrastructure at its site. Please reference 'Barriers to Natural Gas Usage' at the end of this section for more information on this specific challenge and others related to natural gas implementation.

In terms of emissions, the Figure 19 displays the annual amount of each pollutant that could be avoided by an average UWS building in our area of study with a switch from No. 6 to a dual fuel burner[cii].

Pollutant	Before Conversion (lbs)	After Conversion (lbs)	Savings (lbs)	% Reduction
PM (2.5)	519	28	491	95%
Nox	4,782	1,321	3,461	72%
SO2	4,094	336	3,757	92%
VOC	111	66	45	41%
CO	435	500	(65)	-15%
CO2	2,173,748	1,669,431	504,317	23%

Figure 20. Table of Emissions Before and After Transition from No. 6 to Dual Fuel.

To help put these figures in context, the building's 95% reduction in particulate matter would be equivalent to taking 3,780 passengers cars off of the road.[ciii] Furthermore, the 72% reduction in NO_x would be equivalent to removing 138 passenger cars from the road, and the 23% reduction in CO_2 would be equivalent to taking 52 cars off of the road.[civcv] Lastly, the 92% reduction in SO_2 is equivalent to preventing the pollution of coal plants that stems from the annual generation of electricity for 86% of an average American household.[cvi]

As mentioned earlier, 69 out of the 225 boilers in the area of study (about 30.7%) have dual fuel burning capability with their existing burner. These buildings, however, continue to rely on burning No. 6 oil due to its lower cost per gallon. But in conjunction with foreseeable low natural gas prices and mandated fuel conversions in New York City buildings, these 69 sites will be in a better financial position if they were to make the shift from burning solely No. 6 oil to a balance of No. 2 oil and natural gas. By having dual fuel burners already installed, these buildings will be able to forego the $20,000 that other buildings will expense in order to make their boilers capable of burning both No. 2 oil and natural gas.

Figure 20 depicts EIA projections out to 2025, illustrating that natural gas prices are expected to remain low relative to both No. 2 and No. 6 oil[cvii].

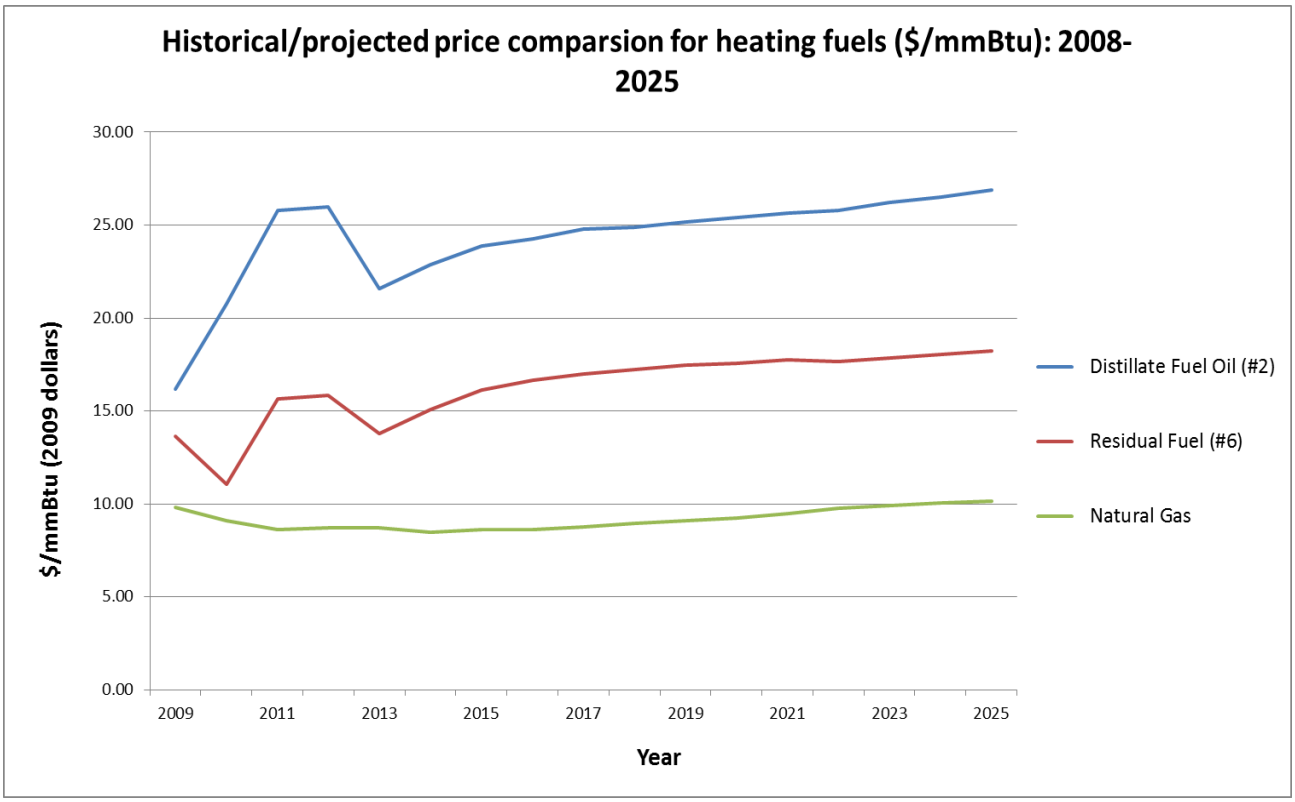


Figure 21. Chart of EIA Historical/Projected Prices of Heating Fuels.

Switch from No. 6 to Natural Gas

Like the conversion from No. 6 to dual fuel, a complete switch to natural gas will yield considerable financial and environmental benefits. Calculations for potential savings are very similar to those above, with the only change occurring in the ratio of burning natural gas to No. 2 oil, now 100% natural gas and 0% No. 2 oil. The table below shows the total savings that can be achieved as well as the expected payback period, which in this case is lowered to 2.17 years. It is worth noting that even with higher costs for natural gas due to Con Edison's premium ($0.10-0.30) for firm natural gas supply, total fuel expenses will be lower than relying on a balance of No. 2 oil and natural gas.

Building Energy Characteristics (average building site for area of study):

- Annual Energy Consumption: 13,040 mmBTU
- Consumption Rate: 9.893 mmBTU/hour
- Amount of No. 6 oil previously needed: 86,933 gallons

Costs	
Dual fuel burner	$ 20,000
Tank cleaning	$ 3,000
Secure/remove fuel heating equipment	$ 2,000
Chimney cleaning	$ 50,000
Gas Booster	$ 25,000
Natural Gas Piping	$ 18,500
Condensate Pumps	$ 1,000
Operating Costs	
Annual #6 oil expenses	$ 220,096
Annual Tank Heating	$ 1,960
Annual Soot blowing/maintenance	$ 5,000
Total	**$ 227,056**
New Operating Costs	
Annual NG expenses	$ 170,911
Annual Maintenance	$ 1,000
Total	**$ 171,911**
Total Capital Costs	$ 119,500
Annual Savings	$ 55,145
Payback Period (Years)	2.17

Figure 22. Table of Conversion for No. 6 to Solely Natural Gas.

Cost References: Identical to those listed in table for conversion from No. 6 to Dual Fuel

As described earlier, current and projected future low natural gas prices make this conversion financially advantageous. Furthermore, the lower amount of pollutants in natural gas will yield substantial emission savings, creating a healthier environment for all. Figure 22 displays the annual amount of each pollutant that could be avoided by an average UWS building in our area of study with a switch from No. 6 to solely natural gas[cviii].

Pollutant	Before Conversion (lbs)	After Conversion (lbs)	Savings (lbs)	% Reduction
PM (2.5)	519	25	495	95%
Nox	4,782	1,202	3,580	75%
SO2	4,094	8	4,086	100%
VOC	111	70	41	37%
CO	435	511	(76)	-17%
CO2	2,173,748	1,533,490	640,258	29%

Figure 23. Table of Emissions Before and After Transition from No. 6 to Solely Natural Gas.

To help put these figures in context, the building's 95% reduction in particulate matter would be equivalent to taking 3,805 passengers cars off of the road.[cix] Furthermore, the 75% reduction in NO_x would be equivalent to removing 143 passenger cars from the road, and the 29% reduction in CO_2 would be equivalent to taking 66 cars

off of the road.[cxcxi] Lastly, the near 100% reduction in SO_2 is equivalent to preventing the pollution of coal plants that stems from the annual generation of electricity for 94% of an average American household.[cxii]

Other case studies done by EDF also show significant savings of fuel conversion from No. 6 oil to natural gas:

- The 320-unit building located at 20 East 9th Street saves between $20,000 and $30,000 per month by converting from No.6 oil to natural gas[cxiii].
- At Jackson Heights Condominiums, the 214-unit building saved $100,000 in 2009 by converting from No. 6 oil to natural gas[cxiv].
- Fairview at Forest Hills, a 426-unit condo building, converted from No. 6 oil to natural gas in October 2008, seeing its heating bill drop by $190,000 in the following year. [cxv]

Cogeneration Systems

Background

Figure 24. Cogeneration System. Source: http://www.cleantechny.blogspot.com/

Cogeneration (combined heat and power, or CHP) is the use of a heat engine or a power station to simultaneously generate both electricity and useful heat[cxvi]. The heat generated from producing electricity could be used for domestic hot water or space heating. The energy of CHP is much more efficient than other non-renewable power sources. When the waste heat is put to use, the system cycle efficiency could reach 80%[cxvii].

CHP reduces energy needs from utility companies and saves money by not having to pay for transmission and distribution built into utility electricity rates. If the building requires electricity and heat simultaneously, then a cogeneration system could be a wise option. One study shows the current CHP systems provide the largest benefit to buildings with electric bills higher than $100,000 per year and with the CHP system running continuously, thus it is more appropriate for larger buildings[cxviii]. It is good to choose a size of the CHP system that appropriately matches typical electric and heat consumption of the building.

Discussion and Analysis

A good case for CHP adoption is 205 West End Avenue, a 543-unit building in the UWS. The building uses a CHP system with two 150kW natural gas fired generators by CRM Energy System[cxix]. The waste heat is used to produce domestic hot water and increase low-pressure commercial steam to heat the building. The installation of the CHP system reduces the demand on the electrical grid by 300 kilowatts per year and saves 205 West End Condominium $322,049 annually in energy costs. No oil is used in this building as natural gas through the CHP system provides all necessary power.

Various incentive programs are available for owners who install and operate certain types of CHP systems in the Upper West Side. Utility companies like Con Edison offer incentives to install certain types of CHP systems[cxx]. NYSERDA also has several CHP programs, and eligible new installations are allowed to take the Federal Business

Energy Investment Tax Credit[cxxi] that is equal to 10% of total expenditures. Eligible generators include those with up to a two-megawatt (MW) capacity and an electricity-only generation efficiency of 26% or higher.

Fuel Conversion Conclusion and Recommendations

Although attempting to successfully extrapolate financial and emission savings to the entire area of study is difficult, it is worth exploring in order to garner a basic sense of what the potential is for buildings on the UWS in regards to the costs and benefits of different heating sources.

As mentioned earlier, the 225 boilers on the 186 sites within the area of study consume annually on average 2,425,418 mmBTU, a consumption pattern that requires 16,169,454 gallons of No. 6 heating oil and can cost annually upwards of $40,937,948. That amount of consumption nearly mirrors the heat input of Logansport Coal Plant in Indiana, a coal plant of average heat input in the United States which is responsible for over 248,000 tons of carbon dioxide equivalent emissions every year.[cxxii] As a result, there is significant opportunity for improvement when it comes to heating residential co-op buildings on the UWS.

If 50% of the total number of gallons of No. 6 oil that are needed every year was redirected toward a dual fuel set-up, only 8,084,727 gallons of No. 6 would be needed at a cost of $20,468,974. The remaining half of that 50% would translate (assuming 75% natural gas use and 25% No. 2 oil use) to 2,165,552 gallons of No. 2 oil and 8,830,406 therms of natural gas, generating a total annual fuel cost of $16,846,634. Thus, the new annual fuel cost under a dual fuel scenario for 50% of the original fuel input would be $37,315,609 – a savings of $3,622,339 or about 9% from the business as usual case.

This savings does not take into necessary capital costs, but it is quite clear how even a shift of 50% of the originally required heat input can generate fuel cost savings around 9% on an annual basis. A 9% annual savings will still provide a rather quick payback period after necessary capital investments are installed for natural gas supply. In terms of pollution, if the UWS were adhere to this 50% shift to dual fuel, that 50% alone would take the equivalent of over 350,000 passenger cars off the road in terms of particulate matter emissions, about 4,800 cars in terms of CO_2 emissions, and the savings in SO_2 emissions is equivalent to preventing pollution of coal plants that stems from the annual generation of electricity for 80 American homes.

A final important point regarding fuel conversion is the uncertainty regarding future heating fuel prices. Although our model utilized EIA long-term data, history has shown that different fuels, especially natural gas, can be subject to extreme price volatility. As recently seen, this volatility can also exist in the heating oil markets, and can ultimately have an impact on how No. 6, No. 4, and No. 2 heating oil are valued. With the eventual phase out of No. 6 oil, changing demands for the different heating fuels will continue to introduce volatility into the pricing mechanisms and the overall market. Although our team stands by our heating fuel recommendations (noted below), it is prudent to understand and monitor potential changes in heating fuel costs as the GGBP mandates begin to take effect.

Our recommendations regarding fuel conversions of residential co-op buildings in the Upper West Side of New York City include:

- All buildings currently burning No. 6 oil should begin planning a fuel conversion to either a dual fuel system or to solely natural gas. These conversions both have relatively quick economic payback periods and also significant emission reductions.

- Buildings switching to No. 2 oil without adding natural gas should install a heat management system and other efficiency measures to decrease the annual amount of heating oil needed.
- No. 4 and No. 6 oil buildings that already have a dual fuel capable burner (30.7% of buildings in our area of study have this feature), can switch to natural gas without having to purchase to a new burner.
- Large buildings with electric bills higher than $100,000 per year and with high domestic hot water or space heating demand should consider installing a cogeneration system and apply for relevant incentives.
- Become familiar with the mandates of the Greener Greater Building Plan and monitor potential market changes. Although it would be easy to recommend a complete switch to natural gas due to it being the quickest economic payback and generating the highest emission savings, one must keep in mind volatility of natural gas prices. Therefore, a more flexible heating option of a dual fuel system may be appropriate. The interruptible natural gas rate implemented with a dual fuel system is cheaper, thus offering another incentive for buildings.

Barriers to Natural Gas Usage

Our analysis concludes that natural gas is the not only the most economical solution, but it is also the most environmentally friendly of the fuel options tested. Although we highly recommend making the conversion to natural gas, there are some barriers to its immediate adoption. These barriers include infrastructure problems as well as opposition groups against natural gas.

Although the buildings in our study may already have piping for domestic natural gas (i.e. for stoves and dryers), the building needs more gas in order to adopt gas as a primary heating fuel. Thus, the building requires two items in order to use gas, an upgrade in the distribution line into the building and a steel lined chimney.

In order to upgrade the distribution line, the building will need the cooperation of Con Edison who will need to install a larger pipe and make the connection to the building. If the building is near to a major gas line, Con Edison will do this installation for free, usually in return for accepting a firm, uninterruptable gas rate for the building for the next few years. However, if the building is far from these lines or the building is too small, Con Edison may refuse to install new piping because it is not worth the investment on their part. In order to get around this problem, if there are buildings on the same block that are also looking to use natural gas, they should act together and demand natural gas from Con Edison. When Con Edison sees that there is enough demand that the investment in infrastructure will be worth the benefits of many new customers, they will install the new distribution line and hookup the buildings to this new line.

With a new distribution line, a building can physically start using gas, but in order for the building to be up to code and turn on the gas, the building must use a steel lined chimney for the flue gases. If the building does not already have a steel lined chimney, it could cost approximately $5,000-$10,000 per floor to install, or potentially up to $100,000 to $200,000 for a 10 to 20 story building. However, we factored this cost into our analysis and the total capital improvement cost payback period is still less than 3 years, and thus buildings still come out ahead.

At a larger scale, New York City's natural gas infrastructure is also limited. At this point, the system can accept new buildings primarily burning natural gas, but as that base of gas-burning buildings grows, Con Edison and others will need to expand supply into the city. At this point, new transmission has been approved by the Federal Energy Regulatory Commission for Spectra Energy to extend their Texas Eastern Pipeline 20 miles through New Jersey into lower Manhattan[cxxiii]. This 30-inch pipe will provide an additional 800 million cubic feet

per day (292 billion cubic feet per year) into New York City and Spectra Energy expects to complete the project by November 2013[cxxiv]. This is a massive expansion compared to 393 billion cubic feet currently consumed by 4.7 million residential customers in all of New York State[cxxv]. Thus the city and private enterprise are preparing for massive increase in natural gas demand, allowing utilities, such as Con Edison, to absorb the demand of new customers.

Lastly, there are political implications for using natural gas in New York City. Of particular concern to our recommendations are citizens and environmental groups that are opposed to the use of natural gas. These groups spent money on extensive advertising campaigns that include ads on buses and subways as well as pollsters on the street. Although natural gas may be a cleaner burning fuel than heating oil, there is concern amongst these environmental groups because of the methods used to extract the resource, more specifically, hydraulic fracturing (or what is commonly called "fracking").

Hydraulic fracturing (HF) involves drilling horizontally through a layer of shale rock thousands of feet below the surface and injecting a mixture of water, sand, and chemicals to open pores in the shale to release natural gas. Over the past decade, HF has become widespread in the US and shale-gas now accounts for 23% of total gas production, which is expected to expand to 49% by 2035[cxxvi]. Although HF has greatly expanded natural gas production, anti-fracking groups are concerned about HF's effect on water quality. Not only does HF require a lot of water resources, but HF fluids could contaminate the drinking water with chemicals that drillers are not required to disclose. These chemical additives could contain carcinogenic or toxic substances that can contaminate the water table if they are not properly disposed or there is a leak in the drill casing. Such contamination can make drinking water unsafe to drink. However, the EPA has not definitively concluded that HF causes groundwater pollution, but as of December 2011, the EPA came out with an announcement that HF is 'a likely cause of water pollution'[cxxvii].

As of 2012, New York State continues to have a moratorium on drilling until more research is done on HF's potential effect on pollution and the best ways to regulate it[cxxviii]. Frack Action, one of the anti-fracking organizations in New York State, organized rallies on the UWS to oppose HF that in the past included state senators and celebrity activists[cxxix], thus HF is a well-known issue in New York within the UWS community and with politicians. Until regulations can catch up with the possible environmental issues of HF, some co-op shareholders may be uncomfortable with a switch to natural gas as a primary heating fuel and politicians may avoid natural gas mandates or the creation of programs to encourage natural gas usage.

Although these barriers may provide problems with adopting natural gas, they are surmountable. Joining with other buildings to demand natural gas from Con Edison will enable utility to know that they will have customers ready for their expansion in their distribution and will hookup buildings for gas at no cost. Although some buildings may not have steel-lined chimneys, the economic benefits of gas far outweigh the additional cost of the chimney. Lastly, there will be residents that may be opposed to using natural gas because of its environmental implications of its extraction. At this point, we do not know the full extent of hydraulic fracturing's impact on the environment, but we do know that natural gas burns cleaner than oil and that will greatly improve New York City's air quality.

Heating Controls & System Maintenance

Discussion and Analysis

Installing better heating controls and proper system maintenance provides a great opportunity for savings on operating costs. Currently, building managers must follow the City Housing Maintenance Code when heating their buildings. The Code states that from October to May during the daytime hours, if the temperature falls below 55°F, indoor temperatures must be at least 68°F and at night if the temperature is below 40°F, inside temperatures must be at least 55°F[cxxx]. As a result, buildings simply turn on their boilers on October 1 or have them on any time the outside temperature falls below the threshold outdoor temperature. However, these methods do not account for the indoor temperature throughout the entire building which can be different unit-by-unit. Since steam in the heating system cools when further from the boiler, managers may increase the boiler output to stay in code, as a result, the lower floors near the boiler may get overheated. If there are no heating controls within apartments, tenants may simply open a window to vent off the heat. Additionally, poor maintenance of a heating system also leads to energy losses though leaks and clogged furnaces. A well-tuned heating system with proper maintenance can reduce fuel energy consumption by 40%[cxxxi].

This potential in fuel reduction is a major opportunity for building managers. If buildings can adopt heating controls that account for the actual state of the temperature indoors, they can save on energy and fuel costs while increasing tenant comfort. At a minimum cost, having regular maintenance and a fine-tuned boiler system can save thousands of dollars on fuel consumption.

Basic Controls

The first step a building can take is to implement controls to improve boiler efficiency is to first find the system's efficiency through an annual boiler efficiency test. With this benchmarking, the building superintendent should monitor the system daily and keep a log that the management company's agent can review. In order to have a proper log, three basic controls should be installed for the system:

- *Permanent Stack Thermometer* – If the flue gas temperature is high, that is an indication of inefficiency and a need for maintenance and cleaning. For every 40°F increase in stack temperature, fuel consumption increases 1%[cxxxii].
- *Makeup Water Meter* – Indicates if the water level is stable. If makeup water is needed, there may be a steam leak.
- *Domestic hot water sensor* – This will indicate if the temperature of domestic water is too high. Superintendents can turn down the boiler to both avoid scalding accidents and reduce fuel consumption.

These three devices only cost around $100 each, but will provide basic indicators for the system[cxxxiii].

Boiler and System Maintenance

Regular maintenance will ensure that a boiler and heating system is running efficiently. Simply ignoring maintenance may save money in the short run, but it will easily cost buildings a lot more in fuel costs through reduced efficiency. Such maintenance includes cleaning boiler fire tubes and ensuring that steam traps and air valves function correctly on radiators.

Clogged fire tubes causes heat transfer loss as a layer of soot builds up, and thus should be cleaned regularly. This can be regularly monitored through the measurement of stack temperature (as mentioned in basic controls above).

Radiators should be checked regularly to ensure proper functionality of steam traps and air from hydronic systems should be bled annually to remove excess air. A properly functioning radiator system can save up to 20% in fuel usage, and is thus very important[cxxxiv].

Lastly, boilers and exposed hot water and steam pipes should be wrapped in insulation material to reduce heat losses. If the building performs repairs that require opening up the walls, building manager should take the opportunity to wrap the exposed hot water and steam pipes. This insulation can provide up to 20% savings in heating costs.[cxxxv]

Radiator Controls

Without radiator controls, overheated residents have no other choice than to open a window to let heat escape and thus waste fuel. Controls installed on radiators can ensure tenant comfort as well as provide savings on fuel from 3-20%[cxxxvi]. Such controls include shut-off valves and thermostatic radiator valves (TRV).

Simple shut off values allow for residents to close off individual radiators from incoming steam. Although this provides residents with the option to turn off their unit and can prevent the resident from opening a window, it does not have thermostatic controls to fine tune room temperature.

A TRV provides the thermostatic controls that a simple shut-off value does not provide. These are readily installable on two-pipe hydronic radiator systems and cost $60-$100 per radiator plus installation[cxxxvii]. If there are no values present on a radiator, the cost of a TRV over a shut-off valve is very small.

Figure 25. Example of TRV. Source: http://featureradiators.bttradespace.com/our-galleries/feature-radiators-products/gallery-item?mediaId=759870E745F2C63EE0401BAC7101193D&mediaIdx=34

However, most pre-war high-rise buildings on the UWS use one-pipe steam radiator systems and thus TRVs must be carefully considered and calibrated. A TRV for these systems act as a selective air valve that will only release air from the system when the temperature falls below the thermostat's current setting. However, these valves will be negated if boiler pressure is too high since the steam will force its way into the radiator. Thus, boiler pressures should be kept at their lowest values (1-2 psi) to ensure proper TRV functionality. Regardless of the placement of TRVs, boiler pressure should stay low to increase efficiency and reduce the possibility of a safety issue with scalding-hot radiators[cxxxviii].

Advanced Boiler Controls

Beyond the basic diagnostic boiler controls, there are a number of additional boiler controls and indicators to fine-tune a heating system. These include modulating aquastats, Energy Management Systems (EMS), and zone controls.

A modulating aquastat controls the temperature of water in a hot water boiler much like a thermostat does for air temperature. An aquastat has two sensors, one on the side of the boiler and one on the outside of the building. The aquastat senses changes in outdoor temperature and adjusts the temperature of domestic hot water accordingly. When temperatures are warm, the water in the boiler does not need to be as hot. Thus, having such control can provide savings on fuel cost by as much as 10%[cxxxix]. An aquastat unit costs $100-$300 plus the cost of professional installation[cxl].

Figure 26. Example of an EMS. Source: http://www.stonesriverelectric.com/energy-solutions/energy-management.html

An Energy Management System is an upgrade to most boiler controls since many system controls are made in the context of building managers having to meet NYC codes. However, simply meeting NYC codes does not necessarily make heating systems efficient. Using an EMS over basic boiler controls can save 10-15% on fuel consumption while still meeting code[cxli]. Instead of relying on an outdoor temperature sensor, an EMS incorporates information from temperature sensors located throughout the building to modulate the temperature, the amount of time that the boiler will fire, and control the temperature of domestic hot water. Although an EMS can better assess temperature within a building, there will still be some areas that may be under or overheated, but these areas can be regulated with TRVs on residents' radiators. An EMS costs $8,000 to $20,000 and, depending on the size of the building, has a payback period of 1-5 years based on just the fuel savings[cxlii].

For an even greater level of fine tuning, buildings can invest in zone controls. Since a building will experience natural heating and cooling in different areas of the building (i.e. the south side of the building will receive more direct sunlight than the north side), there is a difference in heating for each section of a building. A building may decide to break the heating distribution into "zones" such that heat is sent only where it is needed. These zones can then be monitored by an EMS. However, older buildings on the UWS only have one heating zone and thus require a complex conversion headed by an expert heating engineer. However, once set up, fuel costs can be reduced by 18%[cxliii].

Improving Domestic Hot Water Efficiency

Building managers can encourage reduced domestic hot water (DHW) usage in residences in order to reduce fuel consumption since DHW is heated from the same source as steam for a radiator system. The reduction in DHW can be mandated through installing flow restrictors faucets and showerheads to 1.5 gallons per minute (gpm) to 2-2.5 gpm. The use of dishwashers should be encouraged and front loaded washing machines should be installed when old machines need to be replaced. Again, making such a mandate would depend on the ownership structure of the building and may have to be enacted by a co-op board or HOA.

Recommendations

Building managers should make sure that they are doing proper maintenance and have controls on their heating systems to promote efficiency and reduce fuel consumption. Simply taking the basic step on proper boiler maintenance and including basic controls and diagnostics costs only hundreds of dollars for up to 20% in fuel savings. Even if the basic steps are being done, buildings should invest in advanced controls for even more

savings. Although they are more expensive, payback periods are short and well worth the cost. Additional changes in residences, such as the addition of TRVs and better window caulking and weather stripping will not only increase efficiency up to 20%, but will also increase tenant comfort which will make a good case for their installation.

BBNY should reach out to CB7 to establish an education program with building managers about the use of heating controls and their savings. However, if building managers are not installing basic controls and not doing proper maintenance, BBNY can work with CB7 to lobby to the city government to improve boiler permitting to include basic controls and more regular maintenance.

Lighting & Appliances

Lighting

Background

Standard incandescent bulbs lose up to 90% of the electricity they consume through heat. In 2007, the U.S. Congress adopted energy efficiency standards for new screw-based light bulbs. Beginning in 2012, these standards will result in the phasing out of inefficient incandescent light bulbs and require new bulbs to use 25 to 30% less energy.[cxliv] These light bulbs are more energy efficient and last longer than standard incandescent bulbs, resulting in lower overall cost over the lifetime of the bulb. Purchasing these bulbs and adopting other lighting efficiency strategies can significantly reduce electricity consumption.

Discussion

Figure 27. Example of LED bulb. Source: http://www.directindustry.com/industrial-manufacturer/led-bulb-73891.html

Making upgrades to lighting is an easy way to reduce energy consumption in a building. Identifying locations in the building that are over lit, unoccupied locations that are lit, or areas where lighting sources can be upgraded to lower wattage alternatives are opportunities to reduce consumption. Building managers should also install LED exit signs and upgrade outdoor lighting where applicable. It is up to individual units to replace incandescent bulbs with compact fluorescent lamps (CFLs) or LED bulbs. While this can generate savings over the long term, it can be challenging to influence residents to pay the larger upfront cost. Management must encourage behavioral changes in multi-family residential units, even though the management typically has no control over the residents' choice of light fixtures or bulbs. One example of how this can be accomplished is by creating a CFL or LED purchasing program within the residential building, making selected bulbs available at wholesale prices.[cxlv] Additionally, educating residents about energy savings from more efficient bulbs, and the increased lifetime of these bulbs versus incandescent bulbs, can be an important step in overcoming this barrier. For a comprehensive overview of energy cost per year with different bulbs, see Appendix A.

Another barrier to fully converting to CFLs is the issue of recyclability. CFL bulbs contain small amounts of mercury, and should not be thrown away. To encourage the use of these efficient bulbs, we recommend that building managers implement recycling programs to collect used CFLs.

Lighting controls can also be used to increase efficiency of a lighting system. These controls include occupancy sensors that ensure an area is illuminated only when occupied, controls that automatically shut off lights at a set time, dimmable ballasts, and daylight harvesting systems using photo sensors, which detect daylight levels and uses lights only when daylight is insufficient. Adopting bi-level lighting in areas such as hallways and stairways that need to be lit according to code can also save energy. Bi-level lighting equips these areas with a mechanism that keeps lights at code-minimum levels when empty, and then switches to normal lighting levels when the area becomes occupied.[cxlvi]

Common areas and hallways of a residential building can also increase energy efficiency of lighting systems by regularly cleaning lamps and fixtures, measuring illumination levels, and decreasing illumination levels to industry standards using one of the above methods whenever possible. Finally, when repainting spaces, using colors that reflect more light may decrease the amount of electric light needed.

Behavioral changes can be encouraged through implementing a green purchasing program for light bulbs. In addition, financing and incentives may be available for the purchase of LED replacement bulbs. Signage in key common areas educating tenants about the energy savings from more efficient light bulbs can also be utilized to encourage purchasing of CFL or LED bulbs.

Recommendations

- Conduct walk-throughs of apartment buildings to identify over lit areas, and reduce consumption by removing some bulbs or fixtures, or switching to lower watt bulbs.
- Coordinate with tenants and encourage the purchasing of more efficient bulbs, such as CLF or LED, to replace standard incandescent bulbs. Look into creating a buying service to provide the residents with efficient bulbs at wholesale prices.
- If you live in a building where lighting controls have not been installed, utilize occupancy sensors, timers, daylight harvesting systems, and bi-level lighting wherever applicable.
- When it is time to repaint indoor spaces, use colors that reflect more light.
- Apply for LED financing.
- Create a CFL recycling program on site.
- Upgrade all indoor and outdoor lighting to LED equivalent bulbs
- Establish green purchasing program that requires or encourages ENERGY STAR rated or high efficiency light bulbs.

Appliances

Energy Efficient Appliances

Appliances are a source of electricity consumption in buildings that can often be replaced with more efficient models, such as ENERGY STAR certified appliances. ENERGY STAR refrigerators, for example, contain high-efficiency compressors, improved insulation, and more precise temperature and defrost mechanisms to improve efficiency. They use at least 15% less energy than required by current federal standards and 40% less energy than conventional models sold in 2001.[cxlvii] ENERGY STAR qualified clothes washers use about 37% less energy and use over 50% less water than regular washers. Many qualified clothes washers also have a greater capacity than conventional models, meaning fewer loads of laundry.[cxlviii] Finally, ENERGY STAR qualified dishwashers are, on average, 10% more energy efficient and 12% more water efficient than standard models.[cxlix] We recommend the following:

Recommendations

- When unit appliances need to be replaced, encourage or require the purchasing of energy efficient appliances, such as ENERGY STAR labeled.

Sub-metering & Building Envelope

Sub-metering

Background

Multifamily apartment buildings can be metered for electricity in different ways. Many are master-metered, meaning the building receives only one electric bill from the utility for the entire building. Most master-metered buildings were built before the 1960s, when electricity cost was low[cl]. One benefit of master-metering a building is that the electricity rate charged for the entire building can be significantly lower than the retail residential rate, which would be applied to individual units.[cli] However, this measure has its own shortcomings. According to Con Edison data, only 10% of the residents usually consume 20-25% of total building's electricity[clii]. In the same apartment, some individuals could use more than 5 times more electricity than others while all the residents are paying the same rate. For example, some residents in New York may choose to spend their winter months in Florida while they are stilling paying their utility bills for their New York houses. In a direct-metered building, the utility still owns the meters, but each individual unit is metered separately and residents receive an electric bill from the utility at the residential retail rate. The building would receive a separate electric bill covering common spaces at a commercial retail rate.[cliii]

A sub-metered building combines these features. Building-owned meters, in addition to a master-meter for the building's common spaces, measure individual units. In this way, the building is able to continue purchasing electricity at the less expensive commercial residential rate, but each resident's electricity usage is accurately measured and costs are allocated to residents. Residents are charged only for the electricity they consume, rather than based on apartment size or shares in a cooperative. Therefore, in a sub-metered complex, residents have more control of their total housing costs. This can provide an incentive for residents to lower their electricity consumption. Sub-metering also produces data that can be analyzed to determine if there are problems with heating/cooling systems, appliances, etc.[cliv]

Discussion and Analysis

Sub-metering is one of the best ways to solve the problem on fairness and stimulate residents to save energy when bills are based on their actual energy consumption. Advanced sub-metering involves the installation of a master meter in each building, as well as a sub-meter for each apartment unit and the common area[clv]. The building owner can still purchase the electricity via the master meter at a commercial bulk rate and charge residents by actual electricity consumption measured by individual meters. Figure 21 shows this process below[clvi].

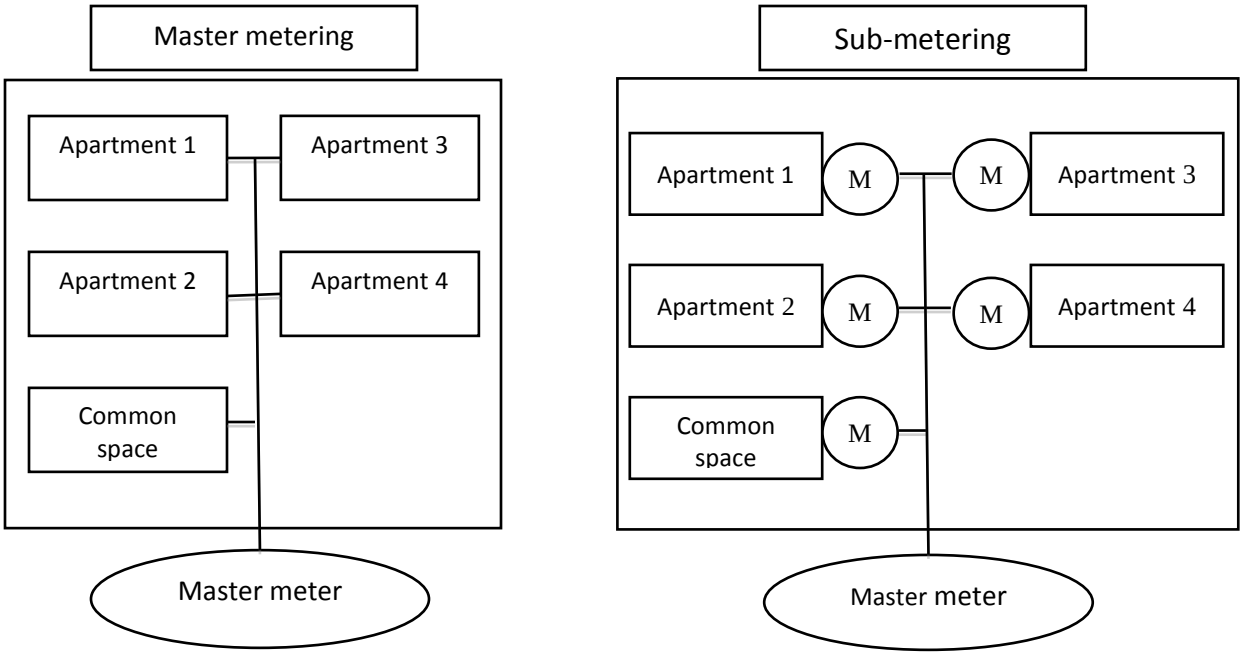


Figure 28. Organizational Structure of Master Metering vs. Sub-metering.

After sub-metering, residents have strong incentives to save energy for their own benefits. Nearly 60-70% of residents will immediately benefit from sub-metering. The change from master metering to sub-metering will reduce electricity consumption by 10-26% annually[clvii]. The saving lasts over time by the change of residents` energy conservation behaviors and input in energy-efficient appliances.

The cost of sub-metering system varies by different electric loads[clviii] and building characteristics like circuit breakers and space construction. Including installation, warranty and reading fees, the estimated costs for electromechanical meter configuration are from $125 to $250 per apartment, while for electronic meter configuration, the cost may be from $350 to $600 per apartment[clix]. For a family with a bill of $1200 per year before sub-metering, after investing on $400 to install an individual meter without considering government incentives and rebates, and starting saving energy by 15%, it takes about 2 years to recover the cost, which is a cost-effective investment.

Successful Cases

There are numerous successful cases in Upper West Side. 205 West End Avenue is one of them. 205 West End Avenue is a 29-story cooperative residence with 543 dwelling units located at the corner of West End Avenue and 70th Street and built in 1961.

The building used to be master-metered by Con Edison. In 2002, the co-op board members decided to switch to sub-metering[clx]. The sub-metering could reduce energy usage and motivate residents to save energy. According to the Petition of 205 West End Owners Corporation to Sub-meter Electricity, price signals sent to tenants will probably create conservation efforts and realize savings in excess of 30%.

456 of the 543 dwelling units are occupied by shareholders, while the remaining 87 units are occupied by non-shareholder groups and owned by ACP Reality Group Inc. In the canvass for shareholders before, 258 of the participating 429 shareholders voted in favor for sub-metering while 171 opposed. Considering the 87 non-

shareholder tenants may disprove the conversion, a commission approval was conducted and passed.

The sub-metering system installed in this building was manufactured by Schlumberger Industries. Each residence unit now has a separate individual utility meter while the Con Edison master meter is still kept at the same time. Charges are based on actual cost after sub-metering, including a $3 to $4 monthly meter service fee. The total charge cannot exceed the Con Edison residential rate for direct metering. After transition, the sub-metering system combined with the cogeneration system installed in 2004 that could produce around 2.34 million kilowatt-hours of electricity annually, 205 West End Condominium saves more than $322,049 annually in energy costs.

Another case is Jefferson Towers, a high-rise master-metered cooperative with 190 apartments, located at 700 Columbus Avenue on the Upper West Side. It implemented electrical sub-metering during 2003. The installed sub-meter is wall-mounted adjacent to the apartment circuit breaker panel and contains an integral temperature sensor that permits building managers to monitor the indoor temperature and optimize the building heating system operation. Figure 21 shows a significant amount of reduction on electricity consumption during every month of year 2009 compared with baseline year 2001. During the period from February, 2009 to January, 2010, the annual reduction was 260,905 kWh (or 21.0 %), the associated saving was $64,755, which represents 21.04 % saving compared with the adjusted baseline cost during 2001 to 2002 period and a reduction in the building demand of 1,346.3 KW or 38.6 %[clxi] after sub-metering.

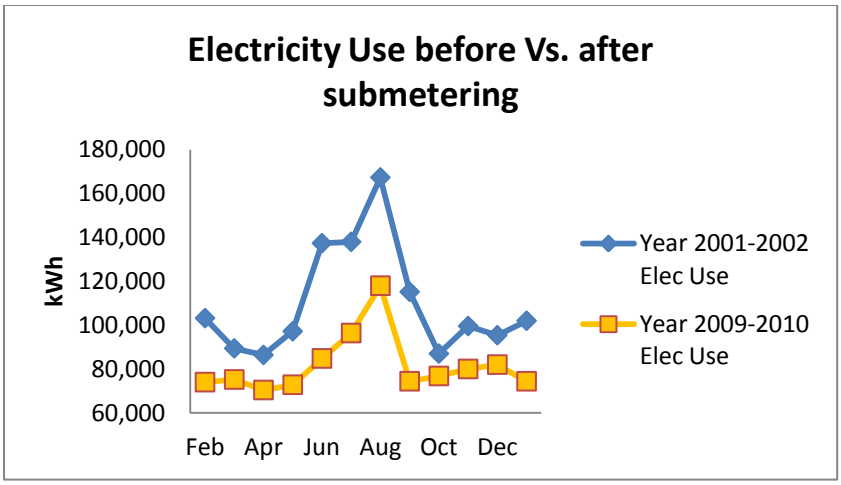


Figure 29. Electricity Use before and after Sub-metering in Jefferson Towers.

Policy incentives

According to NYSERDA (New York State Energy Research and Development Authority), several incentives or tax rebate programs are provided by the New York state government on energy efficient upgrades. Previously, NYSERDA's CEM (Comprehensive Energy Management Program) program provided incentives to fund a percentage of the sub-metering system installation cost in single-family and multi-family apartments. When the cost was under $200 per apartment, NYSERDA would pay 100% of the cost; $200-$299 per apartment, 65%; $300-$399 per apartment, 60 %; $400-$499 per apartment, 55 %; and $500 or greater, 50 %. NYSERDA spent millions of dollars on this program and it was phased out in 2007[clxii], replaced by a new program- NYSERDA's Electric Reduction in Master-Metered Multifamily Buildings (ERMMB) Program[clxiii]. NYSERDA pays $1500 per master meter and up to 50% of the sub-metering system cost or $250 per apartment to condominiums and

cooperatives that make the conversion.

Local Law 88 of 2009 requires that property owners to install sub-meters in all commercial tenant space or floors 10,000 sq. ft. and larger to meet the NYC code[clxiv]. All work will be completed by 2025.

Recommendations

Taking actions to sub-meter the buildings right now is a wise choice and cost-effective short-term investment. Buildings should submit completed application packet to NYSERDA to apply for incentives. After installing equipment as required by program rules, the sub-metering system will be inspected by NYSERDA and receive incentives if meeting the requirements. We recommend building owners to inform their residents on the benefits of sub-metering and educate them that changing energy consumption behavior could save 10-26% energy cost.

Building Envelope

Background, Analysis, and Recommendations

The building envelope is the physical separator between the interior and the exterior environments of a building that helps to maintain the indoor environment, control air flow and energy consumption. The envelope includes the foundation, roof, walls, doors and windows[clxv].

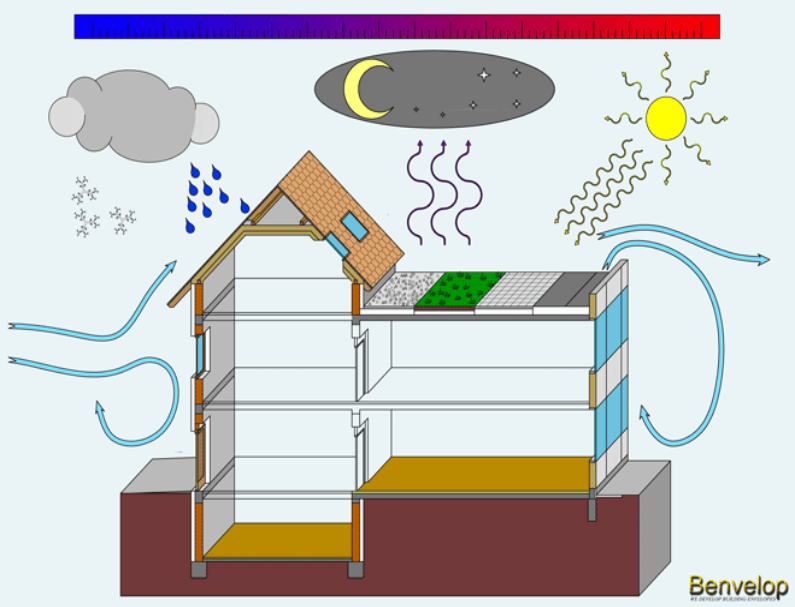


Figure 30. Schematic of building Envelope. Source: http://www.benvelop.com.

The Upper West Side is characterized with large amount of old buildings that were built before 1991 when first energy codes were put into effect. Due to the cold temperature in winter, the space-heating need is especially high. Deep energy retrofitting beyond the common practice of energy-efficiency improvement is involves improving building envelopes. Main work includes improving the exterior building envelope with emerging insulating practices (e.g. installing polyurethane rigid panel insulation, or applying open-cell polyurethane spray foam insulation after build-out[clxvi]), replacing existing windows with energy-efficient ones, and sealing the building's below-grade foundation and roof to the wall connections with insulation. Mechanical practices such as incorporating whole-house ventilation and down-sizing the mechanical plant (HVAC, etc.) are then implemented to complete the overall retrofit. There is great potential to reduce heating and cooling load in this aspect. Performing this deep retrofit comprehensively will typically reduce the whole-building energy load by 40-60 percent.

Many of buildings in study area are historic buildings. Usually, the most effective ways of retrofitting the envelope of historic buildings are controlling all sources of air leakage and having an efficient heat source.

Replacing historic windows with modern windows would be the last choice from the perspective of historic preservation, since much of the heritage character is lost after replacement.

However, there are measures to improve insulation for windows while not affecting their historic nature. For old buildings, wood window frames become tattered and worn over time and will become drafty. These drafty windows should be caulked to close any leaks. Weather stripping can also be installed at the bottom of the frame to further reduce street noise and draft by 90%[clxvii]. Should windows need to be replaced, buildings should invest in double glazed windows that transmit less than half the heat of a single glazed window. Replacing a single glazed window with a double-glazed has a payback of 8-12 years[clxviii].

To further reduce drafts from windows, older buildings that do not have central air conditioning where residents use window air conditioning units should introduce a program to remove these units for the winter months. Window air conditioning units are poorly sealed and thus a large amount of heat is lost throughout the winter. Since window units are heavy and difficult to install, residents simply do not want to deal with moving the unit. Building managers should provide residents ample help with removing air conditioning units in the winter, but such a policy can only be mandated depending on the management structure and would have to be approved by a co-op board.

Because of the high cost of retrofitting on building envelope, this would be a long-term investment. However, in many cases, due to the special characteristics of the buildings with government incentives and tax rebates, the investment could be feasible in short- term.

Green Roofs

Figure 31. The Chicago City Hall green roof. http://science.howstuffworks.com/environmental/green-science/green-rooftop.htm

Green roofs are one concept that can be used to combat the urban heat island effect. Green roofs have been used in Europe for centuries but have only recently started gaining traction in the United States. Germany has emerged as a leader in modern green roof technology and usage where it's estimated that there are more than 800 green roofs that comprise 10% of all flat roofs in the country.[clxix] High profile examples of U.S. green roofs include the Chicago City Hall and Ford Motor Company Dearborn truck plant that has a total green roof area of more than 10 acres.[clxx] Scientists at the U.S. Department of Energy's Lawrence Berkeley National Laboratory (LBNL) estimate that using alternative surfaces to reduce the temperature of ambient air in cities by just 5.4 degrees Fahrenheit (3 degrees Celsius) would save up to $6 billion per year in energy costs, nationwide.[clxxi]

Apart from reducing energy demand, green roofs have the added advantages of storm water management, direct air quality improvement and greenhouse gas reduction through photosynthesis and improved aesthetics. A green roof, or rooftop garden, is a vegetative layer grown on a rooftop. Green roofs provide shade and remove heat from the air through evapotranspiration[13], reducing temperatures of the roof surface and the surrounding air. On hot summer days, the surface temperature of a green roof can be cooler than the air temperature, whereas the surface of a conventional rooftop can be up to 90°F (50°C) warmer.[clxxii]

The main components of a green roof are waterproofing, soil, and plants. Today, there are two distinct types of green roofs: extensive and intensive. An extensive green roof contains shallow soil and low-growing, horizontally spreading plants. These plants are primarily succulents that can thrive in the somewhat alpine conditions of many rooftops. In other words, there is not much water or soil, but the roof does experience a significant amount of exposure to the sun and wind. Intensive green roofs are more complex, and they require more maintenance. They feature deeper soil (usually more than 12 inches in depth) and more diverse plants, such as shrubs and trees. They are usually not as cost-effective as extensive green roofs, and they require more structural support. They are also considered to be less environmentally effective than extensive green roofs.[clxxiii] Estimated costs of installing a green roof start at $10 per square foot for simpler extensive roofing, and $25 per square foot for intensive roofs. Annual maintenance costs for either type of roof may range from $0.75–$1.50 per square foot.[clxxiv]

Storm water management is one direct tangible benefit of green roofs that does not exist for cool roofs. We previously mentioned the negative ecological impacts of storm water runoff in cities that gets heated due to

[13] loss of water from the soil both by evaporation and by transpiration from the plants growing thereon

contact with hot pavements and roofs. Any runoff that occurs from a green roof will have a lower temperature than runoff from a conventional roof, so thermal shock is reduced. Also, on a green roof, rain passes slowly through a layer of soil. This reduces the peak flow rate of the runoff and aids in regulating flow into sewer and water treatment facilities during periods of heavy rain. On an impervious roof, rainwater is usually conveyed quickly to gutters and downspouts as runoff and then pumped through sewers and treatment plants; a green roof, however, can absorb and use much of this rainwater. Thus, green roofs help to reduce the energy costs associated with pumping and treating storm water runoff.

Green roofs absorb heat and act as insulators for buildings, reducing energy needed to provide cooling and heating. No specific studies have been done in the United States on the amount of energy saved by a green roof but a study by the National Research Council of Canada showed that green roofs are very effective in reducing heat transfer through a roof; one green roof reduced average daily energy demand by 75% in a test facility with a 400-square-foot roof.[clxxv]

Not only do green roofs lower production of air pollutants and greenhouse gases by lowering air conditioning demand, but the vegetation on green roofs can also remove these emissions through dry deposition and carbon sequestration and storage, playing a role in improving air quality. For example, a University of Michigan study estimated that the annual public health benefits per metric ton of NO_x reduction are estimated to range from $1683 to $6383. Based on these values, a 2000 m^2 green roof can provide an annual public health benefit of $895 to $3392. According to the same study, greening ten percent of metropolitan roofs in Detroit and Chicago would result in a reduction of annual public health costs between $25.8 million to $97.7 million in Detroit and between $31 million to $118 million in Chicago.[clxxvi]

As of now, Peck (2003) estimates that currently installed green roofs, which cover 6.5 million m^2, reduces NO_x and SO_2 concentrations in the air by a 5-10% reduction and remove 30 tons of particulate matter annually.[clxxvii] The potential benefit of green roofs to remove NO_2, SO_2, CO, PM_{10}, and ozone has been studied using the Urban Forest Effects (UFORE) computer model. The model was developed to quantify the benefits provided by urban forests given local hourly pollution concentrations, meteorological data, and plant-specific air pollution removal rates. Assuming a 50:50 mix of 5evergreen shrubs and grasses, the estimated annual removal of all pollutants by green roofs (per ha.) ranged from 71.95 kg (Toronto) to 83.27 kg (Washington, DC).[clxxviii]

The aesthetic benefits of green roofs can certainly not be ignored. Visually, a green roof is a welcome site in a sea of grey and concrete. They also provided urban habitat for bird and insect life, reduce traffic noise through absorption by the soil layer and potentially increase property value. Properly installed green roofs also protect the roof membrane and increase its longevity.

Researchers and communities are beginning to perform detailed, full life-cycle analyses to determine the net benefits of green roofs. A University of Michigan study compared the expected costs of conventional roofs with the cost of a 21,000-square-foot (1,950 m^2) green roof and all its benefits, such as storm water management and improved public health from the absorption of nitrogen oxides. The green roof would cost $464,000 to install versus $335,000 for a conventional roof in 2006 dollars. However, over its lifetime, the green roof would save about $200,000. Nearly two-thirds of these savings would come from reduced energy needs for the building with the green roof.[clxxix]

Cool Roofs

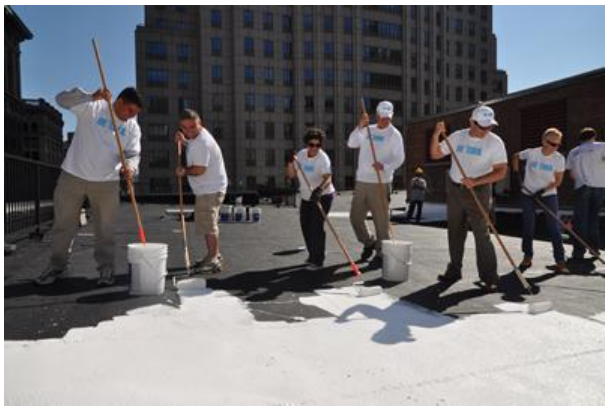


Figure 32. NYC Cool Roof Volunteers. Source: http://www.coolroofs.org/newsletters/CRRC_Summer_2010.html

The purpose of a cool roof is to reflect sunlight and heat away from a building, hence reducing roof temperatures. Cool roofs accomplish this by having a high solar reflectance and a high thermal emittance. Together, these properties help roofs to absorb less heat and stay up to 50–60°F (28–33°C) cooler than conventional materials during peak summer weather. The benefits of cool roofs include reduced energy use and reduced air pollution and greenhouse gas emissions. The reduced heat transfer to the building in the presence of a cool roof means lower energy use for air-conditioning and this reduced energy demand leads to lower emissions of pollutants and greenhouse gases at power plants. Cool roofs are also not very expensive. The cost premium for cool roofs versus conventional roofing materials ranges from zero to 5 or 10 cents per square foot for most products, or from 10–20 cents for a built-up roof with a cool coating used in place of smooth asphalt or aluminum coating. A California study found that cool roofs provide an average yearly net savings of almost 50 cents per square foot. This number includes the price premium for cool roofing products and increased heating costs in the winter as well as summertime energy savings, savings from downsizing cooling equipment, and reduced labor and material costs over time due to the longer life of cool roofs compared with conventional roofs. The New York City government has been actively promoting Cool Roofs through the NYC Cool Roofs program -- a collaboration between the NYC Service and Department of buildings. Con Edison is the lead sponsor of the program. The program provides a variety of useful resources, including a list of vendors who are willing to supply reflective cool roof coatings at discounted rates through the program.

One disadvantage of cool roofs, particularly in colder cities, is that they deflect some desired heat gain during the winter.[clxxx] The effectiveness of cool roofs in mitigating the urban heat island effect has been called into question by researchers at Stanford University's Department of Civil and Environmental Engineering. In their study examining the effects of cool roofs on global and regional climate, Mark Z. Jacobson and John E. Ten Hoeve suggest that if all feedback effects are taken into account, cool roofs might actually result in an increase in temperature. [clxxxi] Part of the reason is the increased need for heating during the winter months. The authors did not consider temperature changes due to reduced emissions associated with lower cooling bills. Their study has, however, created uncertainty about the overall effect of cool roofs on the urban heat island effect.

Since green roofs rely on biochemical means to prevent undesirable heat transfer and insulate the building, they do not have higher heating requirements during winter, unlike cool roofs. Hence, they are definitely a superior concept in dealing with the urban heat island effect. Some disadvantages of green roofs compared to cool roofs include higher initial costs, higher maintenance for plant care and upkeep until plants are fully established, the need for some ongoing maintenance such as fertilizing vegetation, difficulty in locating leaks in waterproofing material, vulnerability to high winds and unsuitability for roofs with steep slopes.

It is worth mentioning that the energy-saving benefits of cool roof and green roof retrofits are greatest when the building in question has a relatively large footprint and a relatively small number of floors. This is because

energy savings due to reduced heat transfer from the roof are almost exclusively limited to the top floor. The other benefits of storm water management, improved aesthetics, reduced noise and potentially greater property value are fairly independent of building height.

Recommendations

Considering the diminishing returns of green roofs as the number of floors increases, green roofs should definitely be considered as a retrofit option in buildings with a small number of floors. Building managers who have to comply with strict storm water regulations should especially consider installing green roofs to manage their storm water runoffs. For taller buildings that cannot justify the added expense of a green roof that benefits only the top floor, cool roofs are a viable option as their initial cost is on marginally higher compared to a conventional roof. However, considering the uncertainty that exists about the overall impact of permanent cool roofs on temperature, especially due to increased heating needs during the winter, it might be worth waiting for more concrete results from ongoing research before making an investment in cool roofs. Building managers could also look into removable 'cool roof solar tarps' that can be used to cover the roof during the summer and then be removed and stored during the winter.

Demand Side Management

Discussion and Analysis

Demand Response (DR) programs are an excellent opportunity for buildings to receive savings and improve their environmental profile without having to spend additional capital on upgrades. These programs allow buildings to get money and gain energy consumption analytics while reducing their carbon footprint, reducing air pollution from electrical generation and deterring the construction of new generation facilities.

DR programs are offered by the utility (i.e. Con Edison on the UWS) and other energy services companies (ESCOs) in order for these entities to gain monetary benefit. When the peak load throughout the city reaches the capacity of the grid, wholesale energy prices become extremely expensive. At these prices, the utility stands to lose a lot of money since retail energy prices do not change with wholesale market prices. Worse is that this peak load could test the stability of the system and may lead to blackouts. In order to save money and maintain the integrity of the grid, utilities and ESCOs offer demand response programs to retail electricity consumers where the consumers can work with the utility to reduce peak loads. This short term relief of demand on the grid, on the order of a few hours to minutes, provides a great benefit on reducing wholesale electricity prices[clxxxii].

Participation in DR programs has a number of environmental benefits beyond the financial benefits for utilities and building managers. Demand response may provide conservation effects from both load reduction and customer awareness of energy usage and costs. By reducing demand in peak periods, inefficient peaking generators will not be as depended upon for marginal power generation. This reduces GHG emissions as well as aid in the reduction of air pollution from generation units, increasing air quality on the hottest of summer days. Lastly, demand response delays the need for utilities to construct additional generation plants, which has a number of environmental and aesthetic benefits by maintaining landscapes and reducing impacts from construction and, later, generation.[clxxxiii]

DR programs come in a number of forms, but the main idea is that the utility will call upon the consumer to lower their demand on the most energy intense days. In some of these programs, demand reduction is either an option or at the will of the utility. Either way, the consumer must elect to be part of these programs.

DR programs exist in two basic forms. There are some programs that give the building the option to reduce electricity or other programs where the building is obligated to reduce their load. For most residential programs, which are option programs, the building will receive advanced notice, a day to only a few minutes ahead, of a possible need for demand reduction event. The building will then have the option to reduce load or maintain its current electricity consumption. This gives buildings the flexibility they need should they not have the ability to reduce demand at that moment in time. However, but not reducing demand, the building forfeits any financial benefits. The financial benefits from an option program are less than that of an obligatory program. Besides being compensated for the energy not used in a demand reduction event, buildings involved in an obligatory program will also receive a subscription fee that compensates the building for removing the option to reduce electricity.

An additional bonus to joining a DR program is that the building may receive additional energy usage analytics from the ESCO for little to no cost. These additional analytics may come in the form of smart meters and/or

energy monitoring software. These analytics provide additional benefits to DR subscribers by showing their energy use profile which building managers can use to identify other areas of the building to reduce energy consumption.

With any of these types of demand response programs, consumers are rarely called upon for reduce their load. Load reduction events on average happen only once or twice a year when the regional load approaches the grid's summer capacity[clxxxiv]. Additionally, depending on the program, buildings have a choice as to how they reduce their demand in a curtailment event, adding a level of customization. For example, air conditioning can still be used in the building, albeit at a lower intensity for as much as a few hours, but still maintaining tenant comfort, or a building may choose to just simply shut down an elevator in an elevator bank. Thus, participation in a demand response program does not greatly affect the either the comfort or operation of the building.

If a building is a large consumer of energy that can make a minimum reduction of 50 kW, a building can apply directly to Con Edison for a demand response program, otherwise it will have to go through a demand response ESCO that aggregates customers. Cons Edison provides a list of certified aggregators[clxxxv].

For further demand side management, beyond the aforementioned efficient lighting and appliances, a co-op would have to affect the behavior of its residents to reduce energy consumption. To promote energy efficient behavior, if the economics are not strong enough, then there would need to be an educational campaign.

Recommendations

Given that demand response programs may require little to no additional investment in capital, building managers should inquire about these programs as a way to make money over the summer months as participation can yield up to thousands of dollars per year. Managers should contact a demand response aggregator ESCO to find a program that is appropriate for the building. The ESCO will determine how much load reduction the building can handle and will pay accordingly. Should the ESCO provide analytics, building managers should use that information to understand the building's energy profile and identify areas for improvement for energy efficiency to produce additional electricity savings. These programs are voluntary and are only activated rarely over the summer causing very little disruption for the building and its tenants. Con Edison provides a list of a multitude of aggregator ESCOs for managers to contact.

BBNY should work with CB7 to inform building managers about the benefits of participating in demand response programs. In return, these building managers will propose the idea to co-op boards who, if the building manager is excited about the opportunity, will likely participate.

Additionally, although behavior may be difficult to change without strong incentives, co-ops can simply institute an educational campaign including facts about saving energy and how it can save residents money. These facts can be posted in areas where all residents will see them in high traffic areas, such as above the lobby elevator buttons. Posting these reminders will be enough for some residents to reduce their electricity consumption.

Enhancing Energy Efficiency Adoption

Although we discuss various technologies and methods that buildings can employ to save on energy costs, it is just as important to suggest how these technologies can be adopted. Barriers to adoption, such as upfront costs, lack of education of decision-makers, and limited infrastructure, must be overcome if energy efficient upgrades will be widely accepted and implemented. Thus, the following recommendations provide a few solutions to get around these obstacles and increase energy efficient technology and methods adoption.

Cluster Demand for Natural Gas – If a building is not large enough nor near a major gas line, then Con Edison may not decide to extend a connection to a building demanding natural gas. To combat this problem, buildings managers should contact nearby buildings on their block and ask if they are demanding natural gas heat. If a cluster of buildings on the same block are demanding natural gas, then Con Edison will more likely make the connection to all of those buildings to lock in hundreds of not thousands of residential units as customers. BBNY should work with CB7 to develop of registry of buildings that demand natural gas and pass this list to Con Edison so they know the demand in the area and can plan to connect more buildings.

Plan Natural Gas Supply for the Future – If enough buildings in New York City consider natural gas, then the city should work with Con Edison to ensure that the infrastructure will be in place to serve new demand. From a transmission standpoint, New York will have ample supply when the East Texas Transmission pipeline extension to lower Manhattan is constructed by the end of 2013. However, Con Edison will be responsible for the development of more distribution lines. Thus, the city will need to work with Con Edison if there is a forecasted distribution installation bottleneck. More distribution will allow for Con Edison to serve more buildings with natural gas.

Develop UWS Purchasing Cooperative – Efficient lighting and appliances may have larger upfront costs. To mitigate this problem, buildings on the UWS can combine to increase their purchasing power through forming a cooperative. If a building is not managed by a major management agency, forming a group that represents the purchasing needs of hundreds of buildings with 10,000+ units will increase purchasing power and reduce prices for all buildings in the purchasing cooperative. We recommend BBNY work with CB7 to explore the idea of developing such a cooperative.

Use Financing Programs for LED Lights – If buildings are really looking to use the most efficient lighting options, these fixtures have high upfront costs. To mitigate these costs, there are a handful of firms that can finance the purchase of efficient lighting. Buildings can then purchase these fixtures while only having to pay a lower monthly lease payment to get the benefits of efficient lighting immediately. We recommend using these financing programs if buildings do not have the cash on-hand for replacing all lighting.

Expand Grant and Loan Programs – Although these programs exist, they only target low-income areas. Grant and loan programs should expand so all buildings in New York City can improve their efficiency and reduce their environmental impact with greater ease. Although city and state budgets may be tight, low-interest loans can be used in place of grants so buildings will still pay for their improvements, but it will greatly reduce upfront costs. BBNY should work with CB7 to advocate the expansion of city or state level grant and low-interest loan programs.

Enhance Information Sharing – In many instances, building managers and co-op shareholders simply do not know of the entire array of solutions that they can employ to make their buildings more efficient. There can be a lot that can be learn through sharing experiences, thus we propose the creation of a quarterly conference for building managers and co-op board members where ideas about energy efficiency can be shared amongst participants. Meetings such as these can simply occur within a common meeting room that many buildings have so that the meeting has little to no cost.

Create Educational Campaigns – Residents should learn about how their choices affect energy use. Co-ops can develop educational campaigns to create awareness. Educational campaigns can be something as simple as posting energy use facts in the lobby, elevators, or other high traffic areas. If residents know they can save on their energy bills by making some simple choices, some will respond. Additionally, awareness of energy usage will allow residents, who are also shareholders, to be more informed when the co-op board puts energy efficiency upgrades to a vote. BBNY should work on a standard set of materials to send to co-op boards and building managers that will contain the most compelling arguments for reducing energy consumption.

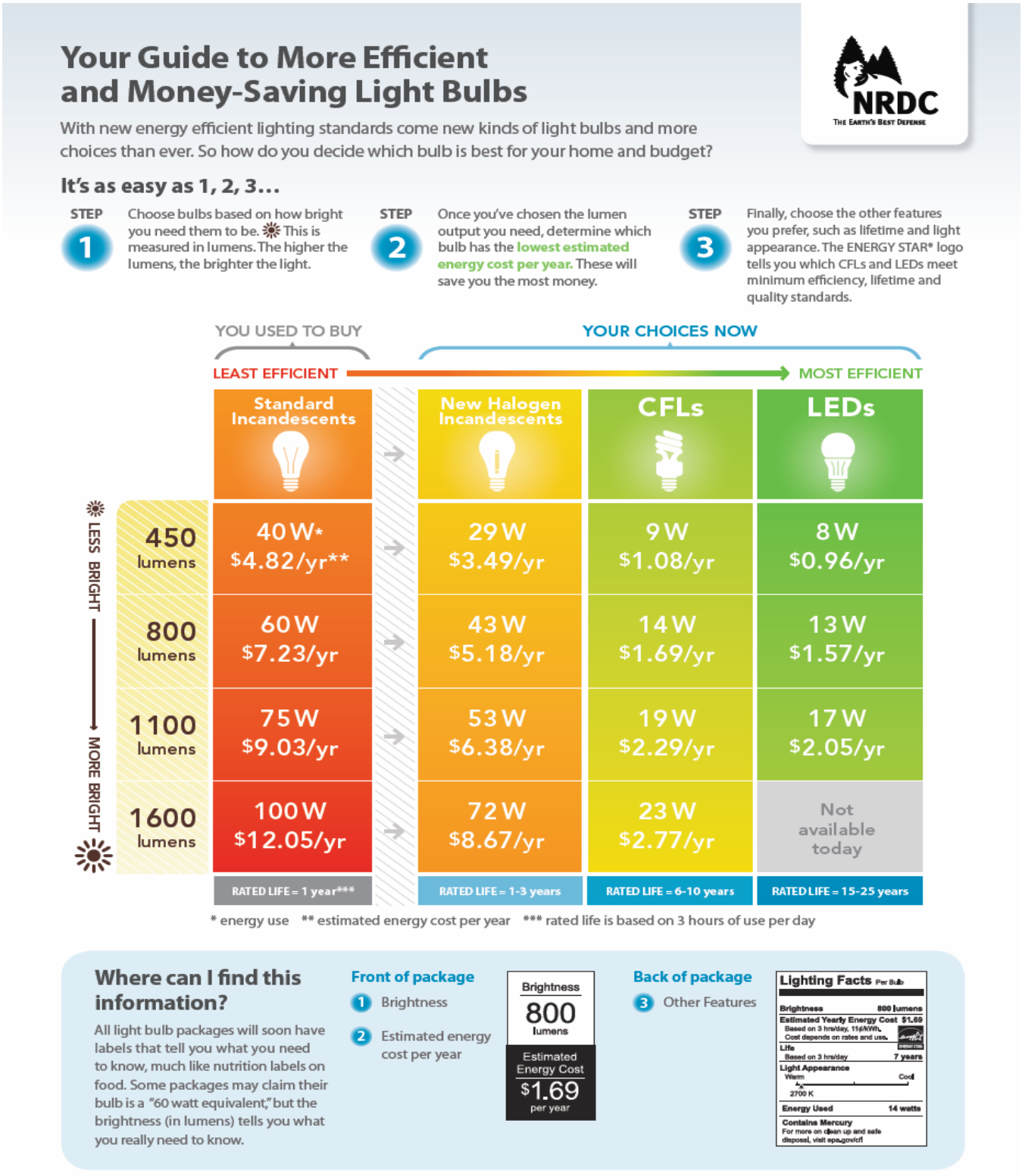
Incorporating any these suggestions will help in technology adoption. Although the merits of the technologies mentioned in this report are plenty to encourage adoption, there is a reason that these are not immediately adopted. Using the above recommendations will help to get around the barriers of adoption and will lead to cleaner, greener buildings.

Conclusion

In conclusion, the recommendations set forth in this report will provide a solid foundation upon which residential co-op building decision-making entities can rely when considering energy-related investments in their respective buildings. Building managers and interested shareholders should prioritize these investments in order to not only generate financial savings for the building and its occupants, but also to do their part in helping to curtail the pollution of New York City and the effects of global climate change. It is also important that policymakers know of the available options for energy efficiency such that they can formulate effective policy to improve the environment while making positive economic choices.

Although we focus on pre-war co-op buildings on the Upper West Side, many of the recommendations from this report can be extrapolated to other large apartment buildings in New York City, if not other cities around the globe. Although efficient building standards, such as LEED, have emerged to improve the energy efficiency of new construction, older existing buildings continue to make up the vast majority of the building stock. To best address the issues of energy efficiency, climate change, and the environment, the greatest potential for improvement is locked within existing buildings. Thus, although newly constructed efficient buildings fulfill environmental objectives, we must address how we can do more with what is already built.

Appendix A: Case Study - Overview of Energy Costs per Year with Different Bulbs



Your Guide to More Efficient and Money-Saving Light Bulbs

NRDC
THE EARTH'S BEST DEFENSE

With new energy efficient lighting standards come new kinds of light bulbs and more choices than ever. So how do you decide which bulb is best for your home and budget?

It's as easy as 1, 2, 3...

STEP 1 Choose bulbs based on how bright you need them to be. This is measured in lumens. The higher the lumens, the brighter the light.

STEP 2 Once you've chosen the lumen output you need, determine which bulb has the **lowest estimated energy cost per year.** These will save you the most money.

STEP 3 Finally, choose the other features you prefer, such as lifetime and light appearance. The ENERGY STAR® logo tells you which CFLs and LEDs meet minimum efficiency, lifetime and quality standards.

YOU USED TO BUY — YOUR CHOICES NOW

LEAST EFFICIENT → MOST EFFICIENT

LESS BRIGHT → MORE BRIGHT

	Standard Incandescents	New Halogen Incandescents	CFLs	LEDs
450 lumens	40 W* $4.82/yr**	29 W $3.49/yr	9 W $1.08/yr	8 W $0.96/yr
800 lumens	60 W $7.23/yr	43 W $5.18/yr	14 W $1.69/yr	13 W $1.57/yr
1100 lumens	75 W $9.03/yr	53 W $6.38/yr	19 W $2.29/yr	17 W $2.05/yr
1600 lumens	100 W $12.05/yr	72 W $8.67/yr	23 W $2.77/yr	Not available today
	RATED LIFE = 1 year***	RATED LIFE = 1-3 years	RATED LIFE = 6-10 years	RATED LIFE = 15-25 years

* energy use ** estimated energy cost per year *** rated life is based on 3 hours of use per day

Where can I find this information?

All light bulb packages will soon have labels that tell you what you need to know, much like nutrition labels on food. Some packages may claim their bulb is a "60 watt equivalent," but the brightness (in lumens) tells you what you really need to know.

Front of package

1. Brightness
2. Estimated energy cost per year

Brightness 800 lumens
Estimated Energy Cost $1.69 per year

Back of package

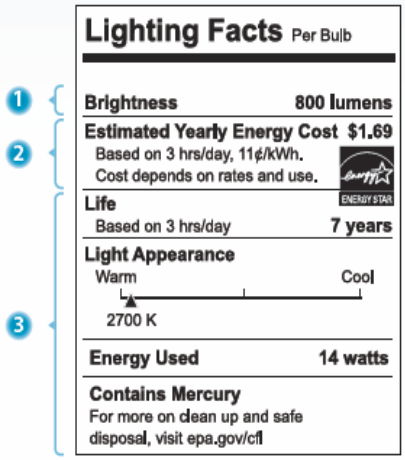
3. Other Features

Lighting Facts Per Bulb
Brightness 800 lumens
Estimated Yearly Energy Cost $1.69
Based on 3 hrs/day, 11¢/kWh. Cost depends on rates and use.
Life
Based on 3 hrs/day 7 years
Light Appearance
Warm Cool
2700 K
Energy Used 14 watts
Contains Mercury
For more on clean up and safe disposal, visit epa.gov/cfl

Why are light bulbs changing?

In 2007, Congress passed and President Bush signed into law the Energy Independence and Security Act (EISA), calling for improved energy efficiency for many products, including light bulbs. You will still be able to buy incandescent bulbs that look and operate like the ones you are used to—they will just use less energy. The law also requires new light bulb labels to help you choose the most efficient bulbs, like LEDs and CFLs.

See the Savings on New Bulb Labels



ENERGY STAR Logo – Indicates which CFLs and LEDs meet ENERGY STAR requirements for efficiency, lifetime and quality.

Life – Estimates in years how long the bulb will last. Long life bulbs save you the hassle of frequent bulb changes.

Light Appearance – Tells you the shade of light. Incandescents produce warm white light—between 2,700 and 3,000 K. Bulbs that produce cooler or more bluish light will have a higher rating, such as 4,000 to 6,500 K.

Energy Used (watts) – Measures bulb energy use, not brightness.

Contains Mercury – CFLs contain extremely low levels of mercury, <5 mg, and are completely safe to use in normal operation. In fact, the amount of mercury inside a CFL is equal to the size of the period at the end of this sentence. Should a CFL break in your home, use common sense clean-up procedures – keep kids away, open the window and carefully clean up the pieces and place them in a zip lock bag for proper disposal. To put this concern in context, mercury emissions from power plants present a much more serious threat to human health and the environment than a broken CFL. Also note, retailers such as Home Depot and Lowes offer free CFL recycling.

Some bulbs last for 1 year and others last for 10 or more. Which bulbs cost the least in the long run?

While a traditional incandescent bulb may be the cheapest to buy, the overall cost of both purchasing and powering the bulb will be nearly four times higher than a CFL. And over the longer life of a CFL those savings can approach 50 dollars. The following table makes plain why more energy efficient bulbs are the best bargain overall.

Bulb Types (all approx. 1600 lumens)	Life	Costs	Year 1	Cost Annually	Total Costs over 6 years
Standard Incandescent 100 W	1 yr*	Bulb Cost	$0.50	$0.50	$3.00
		Energy Cost	$12.05	$12.05	$72.30
		Total Cost	$12.55	$12.55	**$75.30**
Halogen Incandescent 72 W	1 yr	Bulb Cost	$1.50	$1.50	$9.00
		Energy Cost	$8.67	$8.67	$52.02
		Total Cost	$10.17	$10.17	**$61.02**
CFL 23 W	6 yrs	Bulb Cost	$3.00	$0.00	$3.00
		Energy Cost	$2.77	$2.77	$16.62
		Total Cost	$5.77	$2.77	**$19.62**

* rated life is based on 3 hours of use per day

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NRDC
THE EARTH'S BEST DEFENSE

Appendix B: List of All No. 4 or No. 6 Burning Residential (Homes & Asylums, Loft Buildings, Walk Up Apartments, Elevator Apartments) Buildings in the Upper West Side (Zipcodes 10023, 10024, and 10025)[14]

ADDRESS	ZIPCODE	DEP APPLICATION #	DUAL FUEL?	PRIMARY FUEL	#6 PHASE-OUT DEADLINE	NEEDS TO COMPLY WITH GREENER GREATER BLDGS PLAN?
1 WEST 64 STREET	10023	CA305384M		#6	2012	Yes
1 WEST 72 STREET	10023	CA052577X		#6	2012	Yes
1 WEST 85 STREET	10024	CA180192L		#6	2013	Yes
10 WEST 65 STREET	10023	CB105008L	DUAL FUEL	#4	2015	Yes
10 WEST 68 STREET	10023	CA261157K		#4	2013	
10 WEST 74 STREET	10023	CB215001Y	DUAL FUEL	#6	2014	Yes
10 WEST 86 STREET	10024	CA512570H		#6	2013	Yes
10 WEST 86 STREET	10024	CA286355M		#4	2012	Yes
100 RIVERSIDE DRIVE	10024	CA106569R		#6	2013	Yes
100 RIVERSIDE DRIVE	10024	CB013301X	DUAL FUEL	#6	2014	Yes
100 WEST 80 STREET	10024	CA039973L		#4	2015	Yes
100 WEST 93 STREET	10025	CA145396J	DUAL FUEL	#6	2015	Yes
101 CENTRAL PARK WEST	10023	CA003281X		#6	2015	Yes
101 CENTRAL PARK WEST	10023	CA077987J		#6	2014	Yes
101 WEST 80 STREET	10024	CA157080L		#4	2012	
101 WEST 81 STREET	10024	CB545703M	DUAL FUEL	#4	2012	Yes
101 WEST 84 STREET	10024	CA071974N		#4	2015	
101 WEST 85 STREET	10024	CA190591H		#6	2012	Yes
102 WEST 80 STREET	10024	CA329389H		#4	2014	
102 WEST 85 STREET	10024	CA558585Y		#6	2013	Yes
104 WEST 70 STREET	10023	CA101580P		#6	2014	Yes
104 WEST 70 STREET	10023	CB072205R	DUAL FUEL	#6	2015	Yes
1047 AMSTERDAM AVENUE	10025	CA300870P		#6	2015	Yes
105 WEST 73 STREET	10023	CA100282M		#6	2012	
107 WEST 86 STREET	10024	CA204497X	DUAL FUEL	#6	2013	Yes
109 WEST 82 STREET	10024	CA484185X		#4	2013	Yes
11 RIVERSIDE DRIVE	10023	CB201600J	DUAL FUEL	#6	2013	Yes

[14] As of April 2012. Database can be downloaded at https://nycopendata.socrata.com/Facilities-and-Structures/Oil-Boilers-Detailed-Fuel-Consumption-and-Building/jfzu-yy6n.

11 WEST 69 STREET	10023	CA140380M		#4	2014	
11 WEST 81 STREET	10024	CA130898H	DUAL FUEL	#6	2014	
110 RIVERSIDE DRIVE	10024	CA377892L		#4	2014	Yes
110 WEST 86 STREET	10024	CA043889K		#6	2013	Yes
110 WEST 94 STREET	10025	CA122487N		#6	2014	Yes
111 WEST 94 STREET	10025	CA470185Z		#6	2013	
114 WEST 70 STREET	10023	CA100182P		#6	2012	
114 WEST 86 STREET	10024	CA016772N		#6	2015	
115 WEST 73 STREET	10023	CA252584K		#6	2014	Yes
115 WEST 86 STREET	10024	CB135603K	DUAL FUEL	#6	2013	Yes
116 WEST 72 STREET	10023	CA122398L	DUAL FUEL	#6	2013	Yes
117 WEST 70 STREET	10023	CA186781R		#6	2015	Yes
117 WEST 79 STREET	10024	CA138485X		#4	2012	
118 WEST 79 STREET	10024	CA288087Y		#6	2014	Yes
118 WEST 95 STREET	10025	CA243682J		#4	2014	
119 WEST 71 STREET	10023	CA183386N		#4	2013	Yes
12 WEST 96 STREET	10025	CA011284L		#6	2015	Yes
120 WEST 105 STREET	10025	CA250881H		#4	2015	Yes
121 WEST 72 STREET	10023	CA108297L	DUAL FUEL	#6	2013	Yes
123 WEST 93 STREET	10025	CA083387R		#6	2014	Yes
124 WEST 60 STREET	10023	CA138385Z		#6	2013	Yes
124 WEST 72 STREET	10023	CB258201X	DUAL FUEL	#4	2014	
124 WEST 79 STREET	10024	CB132402Y	DUAL FUEL	#6	2015	Yes
124 WEST 93 STREET	10025	CA017189K		#6	2013	Yes
125 RIVERSIDE DRIVE	10024	CB280202J	DUAL FUEL	#6	2012	Yes
125 WEST 96 STREET	10025	CB528203J	DUAL FUEL	#6	2014	
126 WEST 96 STREET	10025	CA223373H		#4	2015	
127 WEST 79 STREET	10024	CA052280P		#6	2013	Yes
127 WEST 82 STREET	10024	CA021976L		#4	2013	
129 WEST 89 STREET	10024	CA390987K		#4	2014	
130 WEST 86 STREET	10024	CA285783Y		#6	2013	Yes
131 RIVERSIDE DRIVE	10024	CA359984J		#6	2014	Yes
131 WEST 86 STREET	10024	CA330186X		#4	2013	
134 WEST 93 STREET	10025	CA168485N		#6	2015	
135 CENTRAL PARK WEST	10023	CA281493H	DUAL FUEL	#4	2013	Yes
136 WEST 109 STREET	10025	CA258583X		#6	2015	
137 RIVERSIDE DRIVE	10024	CA489486M		#6	2014	Yes
139 WEST 82 STREET	10024	CA004891H		#6	2012	Yes
140 RIVERSIDE DRIVE	10024	CA031899X	DUAL FUEL	#6	2014	Yes
140 WEST 71 STREET	10023	CA194490R		#4	2015	Yes
140 WEST 72 STREET	10023	CA002086X		#4	2013	Yes
140 WEST 79 STREET	10024	CA113474J		#6	2014	Yes
140 WEST 86 STREET	10024	CA211194Y		#6	2012	Yes
142 WEST 83 STREET	10024	CA511685N		#4	2014	

144 WEST 86 STREET	10024	CA234596Z	DUAL FUEL	#6	2015	Yes
145 CENTRAL PARK WEST	10023	CA139183P		#6	2015	Yes
145 CENTRAL PARK WEST	10023	CA042184X		#6	2014	Yes
145 WEST 71 STREET	10023	CA182087Z		#6	2015	Yes
145 WEST 79 STREET	10024	CA483287M		#4	2013	Yes
145 WEST 86 STREET	10024	CA112881M		#4	2014	Yes
145 WEST 96 STREET	10025	CA493785Y		#6	2013	Yes
147 WEST 70 STREET	10023	CA285394K		#4	2015	Yes
147 WEST 79 STREET	10024	CA157783H		#6	2013	Yes
15 CENTRAL PARK WEST	10023	CA180571L		#6	2014	Yes
15 WEST 67 STREET	10023	CA580786L		#6	2014	Yes
15 WEST 75 STREET	10023	CA028193R		#4	2014	Yes
15 WEST 81 STREET	10024	CA147282K		#6	2013	Yes
15 WEST 84 STREET	10024	CA281192Y		#6	2014	Yes
150 RIVERSIDE DRIVE	10024	CA019383N		#4	2013	Yes
150 RIVERSIDE DRIVE	10024	CB567003M	DUAL FUEL	#4	#N/A	Yes
150 WEST 80 STREET	10024	CA294071K		#6	2013	Yes
150 WEST 82 STREET	10024	CA349885P		#6	2012	
150 WEST 87 STREET	10024	CB158302J	DUAL FUEL	#6	2015	Yes
151 CENTRAL PARK WEST	10023	CA167296J	DUAL FUEL	#6	2014	Yes
151 CENTRAL PARK WEST	10023	CA332170K		#6	2013	Yes
151 WEST 74 STREET	10023	CA042698N	DUAL FUEL	#4	2013	
155 RIVERSIDE DRIVE	10024	CA389385P		#6	2012	Yes
155 WEST 68 STREET	10023	CA132381Y		#6	2015	Yes
155 WEST 71 STREET	10023	CA280783L		#6	2014	
155 WEST 81 STREET	10024	CA405187L		#6	2014	Yes
156 WEST 86 STREET	10024	CA237583N	DUAL FUEL	#6	2013	Yes
157 WEST 79 STREET	10024	CA233199K	DUAL FUEL	#6	2015	Yes
158 WEST 77 STREET	10024	CA007589K		#4	2013	Yes
16 WEST 61 STREET	10023	CA222383R		#6	2014	Yes
160 RIVERSIDE DRIVE	10024	CB083508N	DUAL FUEL	#6	2015	Yes
160 WEST 71 STREET	10023	CA256783L		#6	2014	Yes
160 WEST 73 STREET	10023	CA091875X		#6	2014	Yes
160 WEST 73 STREET	10023	CB148608X	DUAL FUEL	#6	2015	Yes
160 WEST 85 STREET	10024	CA451887J	DUAL FUEL	#4	2015	Yes
160 WEST 87 STREET	10024	CA260288X		#6	2013	Yes
160 WEST 95 STREET	10025	CA212680Y		#4	2012	Yes
161 WEST 61 STREET	10023	CA342287N		#6	2014	Yes
161 WEST 75 STREET	10023	CA045576Z		#6	2015	Yes
161 WEST 86 STREET	10024	CA054177X		#6	2015	Yes
164 WEST 75 STREET	10023	CA005184N		#6	2015	Yes
164 WEST 79 STREET	10024	CA057880L		#6	2014	Yes
165 WEST 66 STREET	10023	CA065176H		#6	2015	Yes
165 WEST 83 STREET	10024	CA117878Y		#6	2013	

165 WEST 91 STREET	10024	CB568303X	DUAL FUEL	#6	2014	Yes
166 WEST 72 STREET	10023	CA287581P		#6	2015	Yes
166 WEST 87 STREET	10024	CA167470X		#6	2015	Yes
168 WEST 86 STREET	10024	CA059578J		#6	2015	Yes
17 WEST 106 STREET	10025	CA397884J		#4	2014	
17 WEST 67 STREET	10023	CB509803Z	DUAL FUEL	#4	2015	Yes
17 WEST 71 STREET	10023	CA125078X		#6	2014	Yes
171 WEST 71 STREET	10023	CA310872H		#6	2015	Yes
171 WEST 79 STREET	10024	CA280086X		#6	2014	Yes
171 WEST 81 STREET	10024	CB120500Y	DUAL FUEL	#6	2014	
173 /175 WEST 93 STREET	10025	CA061778R		#6	2013	Yes
173 WEST 78 STREET	10024	CA204199H	DUAL FUEL	#6	2012	Yes
175 WEST 72 STREET	10023	CB549003L	DUAL FUEL	#6	2013	Yes
175 WEST 72 STREET	10023	CB103500M	DUAL FUEL	#6	2012	Yes
175 WEST 73 STREET	10023	CA235285X		#6	2013	Yes
175 WEST 73 STREET	10023	CA235185Z		#6	2013	Yes
175 WEST 76 STREET	10023	CA310587Z		#6	2014	Yes
175 WEST 92 STREET	10025	CA368488P		#4	2013	Yes
175 WEST 93 STREET	10025	CA394090Y		#6	2015	Yes
176 WEST 87 STREET	10024	CA314585N		#6	2013	Yes
18 WEST 70 STREET	10023	CA302693M		#6	2015	Yes
180 RIVERSIDE BOULEVARD	10025	CA068398R	DUAL FUEL	#6	2015	Yes
180 WEST 93 STREET	10025	CA367988R		#4	2013	Yes
1841 BROADWAY	10023	CA343170Y		#6	2015	Yes
186 RIVERSIDE DRIVE	10024	CB086806J	DUAL FUEL	#6	2012	Yes
1886 BROADWAY	10023	CA064478Z	DUAL FUEL	#6	2015	
190 RIVERSIDE DRIVE	10024	CB533303R	DUAL FUEL	#4	2014	Yes
1900 BROADWAY	10023	CA031577N		#6	2013	Yes
194 RIVERSIDE DRIVE	10025	CA105873R		#6	2012	Yes
1995 BROADWAY	10023	CA197872X		#4	2013	Yes
2 WEST 67 STREET	10023	CA220795Y	DUAL FUEL	#6	2013	Yes
20 WEST 77 STREET	10024	CA133796K	DUAL FUEL	#4	2014	Yes
20 WEST 84 STREET	10024	CA095479M	DUAL FUEL	#6	2014	Yes
20 WEST 86 STREET	10024	CA336092M		#6	2013	Yes
20 WEST 86 STREET	10024	CB161303N	DUAL FUEL	#6	2012	Yes
20 WEST END AVENUE	10023	CA405869Z		#6	2014	
200 WEST 108 STREET	10025	CA288385M		#6	2012	Yes
200 WEST 60 STREET	10023	CA326791M		#6	2013	Yes
200 WEST 79 STREET	10024	CA332890Z		#6	2014	Yes
200 WEST 86 STREET	10024	CA007980N		#6	2015	Yes
200 WEST 86 STREET	10024	CA079583M		#6	2013	Yes
200 WEST 90 STREET	10024	CB497403L	DUAL FUEL	#6	2014	Yes
200 WEST 93 STREET	10025	CA127380X		#4	2014	Yes

201 WEST 105 STREET	10025	CA282588P		#4	2013	
201 WEST 109 STREET	10025	CA065577Z		#6	2012	
201 WEST 77 STREET	10024	CB141703R	DUAL FUEL	#6	2013	Yes
201 WEST 79 STREET	10024	CA377770N	DUAL FUEL	#4	2015	Yes
201 WEST 85 STREET	10024	CA114477J		#6	2012	Yes
201 WEST 89 STREET	10024	CA130172Z		#6	2013	Yes
202 RIVERSIDE DRIVE	10025	CB007108K	DUAL FUEL	#6	2012	Yes
2020 BROADWAY	10023	CA252483L		#6	2015	
203 WEST 107 STREET	10025	CA155082X		#6	2013	
203 WEST 90 STREET	10024	CA061779Z		#6	2013	
203 WEST 94 STREET	10025	CA385589Z		#4	2014	
204 WEST 109 STREET	10025	CB015708X	DUAL FUEL	#4	#N/A	
204 WEST 94 STREET	10025	CB280002N	DUAL FUEL	#4	2013	
205 WEST 103 STREET	10025	CA403587L		#4	2014	
205 WEST 88 STREET	10024	CA241191X		#6	2012	Yes
205 WEST 89 STREET	10024	CA120297N	DUAL FUEL	#6	2012	Yes
205 WEST 95 STREET	10025	CA143990N		#4	2014	Yes
206 WEST 92 STREET	10025	CA049786P		#4	2013	
207 WEST 106 STREET	10025	CA356986J		#6	2014	Yes
209 WEST 104 STREET	10025	CA089080J		#6	2013	
209 WEST 97 STREET	10025	CB490903Z	DUAL FUEL	#6	2014	Yes
210 RIVERSIDE DRIVE	10025	CA123281M		#6	2015	Yes
210 WEST 101 STREET	10025	CB091006N	DUAL FUEL	#6	2013	Yes
210 WEST 101 STREET	10025	CA020973L		#4	2012	Yes
210 WEST 89 STREET	10024	CA271892X		#6	2013	Yes
210 WEST 94 STREET	10025	CA091978Z		#6	2013	Yes
2109 BROADWAY	10023	CA009081Z		#6	2014	Yes
2109 BROADWAY	10023	CA008981J		#6	2014	Yes
211 CENTRAL PARK WEST	10024	CB245002K	DUAL FUEL	#6	2012	Yes
211 CENTRAL PARK WEST	10024	CB261401N	DUAL FUEL	#6	2014	Yes
211 WEST 106 STREET	10025	CA356886M		#6	2014	Yes
211 WEST 61 STREET	10023	CB207605H	DUAL FUEL	#6	2015	Yes
212 WEST 85 STREET	10024	CA192296Y	DUAL FUEL	#6	2015	Yes
2121 BROADWAY	10023	CB062300R	DUAL FUEL	#4	2012	
214 WEST 92 STREET	10025	CA269893P		#6	2014	Yes
215 WEST 101 STREET	10025	CA281996J	DUAL FUEL	#6	2015	Yes
215 WEST 78 STREET	10024	CA045776N		#6	2012	Yes
215 WEST 88 STREET	10024	CA281095M	DUAL FUEL	#6	2014	Yes
215 WEST 90 STREET	10024	CA348195N	DUAL FUEL	#4	2014	Yes
215 WEST 90 STREET	10024	CA250396Y	DUAL FUEL	#4	2013	Yes
215 WEST 91 STREET	10024	CB566703K	DUAL FUEL	#6	2014	Yes
215 WEST 92 STREET	10025	CB311100K	DUAL FUEL	#6	2013	Yes
215 WEST 98 STREET	10025	CA310888M		#6	2013	Yes
216 WEST 102 STREET	10025	CB130108H	DUAL FUEL	#4	2013	

216 WEST 89 STREET	10024	CA187498X	DUAL FUEL	#6	2013	Yes
2166 BROADWAY	10024	CA174481R	DUAL FUEL	#6	2015	Yes
219 WEST 81 STREET	10024	CB135408H	DUAL FUEL	#6	2015	
22 RIVERSIDE DRIVE	10023	CA114887M		#4	2014	
22 WEST 69 STREET	10023	CA535385H		#4	2015	
22 WEST 77 STREET	10024	CA063683N		#4	2013	
220 WEST 107 STREET	10025	CA068993L		#6	2014	Yes
220 WEST 71 STREET	10023	CA007870M		#4	2014	
220 WEST 93 STREET	10025	CA048379N		#6	2013	Yes
220 WEST 98 STREET	10025	CB099108J	DUAL FUEL	#6	2015	Yes
2200 BROADWAY	10024	CB225701X	DUAL FUEL	#6	2014	Yes
221 WEST 82 STREET	10024	CA321189R		#6	2012	Yes
222 RIVERSIDE DRIVE	10025	CA140789H		#4	2013	Yes
222 WEST 83 STREET	10024	CA047779H		#6	2015	Yes
224 RIVERSIDE DRIVE	10025	CA350285J		#4	2013	
225 CENTRAL PARK WEST	10024	CA118577P		#6	2013	Yes
225 CENTRAL PARK WEST	10024	CB188607L	DUAL FUEL	#6	2014	Yes
225 WEST 106 STREET	10025	CA488987X		#6	2015	Yes
225 WEST 71 STREET	10023	CA126796P	DUAL FUEL	#6	2014	
225 WEST 80 STREET	10024	CA360684X	DUAL FUEL	#4	2014	
227 CENTRAL PARK WEST	10024	CA330388Y		#4	2012	
229 WEST 101 STREET	10025	CA175383H		#4	2013	
229 WEST 97 STREET	10025	CB249900P	DUAL FUEL	#4	2013	Yes
23 WEST 73 STREET	10023	CB042703Z	DUAL FUEL	#6	2012	Yes
23 WEST 73 STREET	10023	CA021596J	DUAL FUEL	#6	2014	Yes
230 RIVERSIDE DRIVE	10025	CA145899L	DUAL FUEL	#6	2015	
230 WEST END AVENUE	10023	CA147382H		#6	2012	Yes
2315 BROADWAY	10024	CA171999H	DUAL FUEL	#6	2015	
233 WEST 77 STREET	10024	CA109280J		#6	2013	Yes
233 WEST 83 STREET	10024	CA377292H		#4	2014	Yes
235 WEST 102 STREET	10025	CA043689X		#6	2012	Yes
235 WEST 103 STREET	10025	CA267471X		#6	2012	
235 WEST 71 STREET	10023	CA045782J	DUAL FUEL	#4	2012	
235 WEST 76 STREET	10023	CA027688Y		#6	2015	Yes
235 WEST 76 STREET	10023	CB042203H	DUAL FUEL	#6	2012	Yes
235 WEST END AVENUE	10023	CA091691L		#6	2012	Yes
2350 BROADWAY	10024	CA251282K	DUAL FUEL	#6	2015	Yes
2350 BROADWAY	10024	CB138400N	DUAL FUEL	#6	2012	Yes
238 WEST 106 STREET	10025	CA252783N		#6	2014	Yes
239 CENTRAL PARK WEST	10024	CB001003Y	DUAL FUEL	#6	2014	Yes
241 WEST 97 STREET	10025	CA000488J		#6	2012	Yes
243 WEST 63 STREET	10023	CA069779P		#6	2013	
243 WEST 70 STREET	10023	CA124978R		#6	2012	Yes
243 WEST 98 STREET	10025	CA194881Y		#6	2013	Yes

243 WEST 99 STREET	10025	CA192191H		#6	2013	
243 WEST END AVENUE	10023	CA264482H		#6	2013	Yes
244 RIVERSIDE DRIVE	10025	CA225397L	DUAL FUEL	#6	2013	
244 WEST 72 STREET	10023	CA320195Z	DUAL FUEL	#4	2014	Yes
244 WEST 99 STREET	10025	CA353089X		#6	2014	
245 WEST 104 STREET	10025	CA037778R		#6	2015	Yes
245 WEST 107 STREET	10025	CA367572N		#6	2015	Yes
245 WEST 74 STREET	10023	CA096981M		#6	2014	Yes
245 WEST 75 STREET	10023	CA279773J		#4	2013	
247 WEST 87 STREET	10024	CB104603H	DUAL FUEL	#4	2012	Yes
25 WEST 64 STREET	10023	CA079877H		#6	2015	
25 WEST 68 STREET	10023	CB152200L	DUAL FUEL	#6	2015	Yes
25 WEST 81 STREET	10024	CB233101N	DUAL FUEL	#6	2014	Yes
250 RIVERSIDE DRIVE	10025	CA148268Z		#6	2014	Yes
250 WEST 75 STREET	10023	CA279673M		#6	2014	
250 WEST 78 STREET	10024	CA035282Y		#6	2013	
250 WEST 82 STREET	10024	CA298492R		#4	2014	Yes
250 WEST 89 STREET	10024	CA088687L		#4	2015	Yes
250 WEST 90 STREET	10024	CA664286N		#6	2014	Yes
250 WEST 94 STREET	10025	CA397784M		#6	2015	Yes
2508 BROADWAY	10025	CA084585M		#6	2012	Yes
251 WEST 100 STREET	10025	CA077182M		#4	2013	
251 WEST 74 STREET	10023	CA333267L		#4	2015	
251 WEST 81 STREET	10024	CB402505Z	DUAL FUEL	#4	2015	Yes
251 WEST 87 STREET	10024	CA467887X		#4	2013	Yes
251 WEST 98 STREET	10025	CA336991X		#4	2013	
252 WEST 76 STREET	10023	CB118401R	DUAL FUEL	#4	2013	Yes
252 WEST 85 STREET	10024	CA191181J		#6	2012	Yes
253 WEST 72 STREET	10023	CA293586P		#6	2013	Yes
255 WEST 108 STREET	10025	CA319193R		#6	2015	Yes
255 WEST 88 STREET	10024	CA005284K		#6	2014	Yes
255 WEST 88 STREET	10024	CB567603L	DUAL FUEL	#6	#N/A	Yes
255 WEST 90 STREET	10024	CA046198P	DUAL FUEL	#6	2013	Yes
255 WEST END AVENUE	10023	CA519385H		#6	2013	Yes
257 CENTRAL PARK WEST	10024	CB400305Y	DUAL FUEL	#6	2015	Yes
258 RIVERSIDE DRIVE	10025	CA207396K	DUAL FUEL	#6	2015	Yes
259 WEST 109 STREET	10025	CB491503P	DUAL FUEL	#4	2014	
260 RIVERSIDE DRIVE	10025	CB177803N	DUAL FUEL	#6	2013	Yes
260 WEST 78 STREET	10024	CA026982K	DUAL FUEL	#6	2012	Yes
260 WEST END AVENUE	10023	CA199896J	DUAL FUEL	#6	2014	Yes
262 CENTRAL PARK WEST	10024	CA348088H		#6	2013	Yes
265 RIVERSIDE DRIVE	10025	CA069773Y		#6	2014	Yes
265 WEST 81 STREET	10024	CB402305M	DUAL FUEL	#4	2015	
269 WEST 72 STREET	10023	CA251287J		#4	2015	

27 WEST 67 STREET	10023	CA121284Z		#6	2014	Yes
27 WEST 86 STREET	10024	CB141203X	DUAL FUEL	#6	2012	Yes
27 WEST 96 STREET	10025	CA149680P		#6	2012	Yes
270 RIVERSIDE DRIVE	10025	CA102197R	DUAL FUEL	#6	2013	Yes
270 WEST END AVENUE	10023	CB053801P	DUAL FUEL	#4	2013	Yes
271 CENTRAL PARK WEST	10024	CA079876X		#6	2014	Yes
275 CENTRAL PARK WEST	10024	CA087086L		#6	2013	Yes
275 WEST 96 STREET	10025	CA172782L	DUAL FUEL	#6	2014	Yes
276 RIVERSIDE DRIVE	10025	CA403088R		#6	2013	Yes
276 RIVERSIDE DRIVE	10025	CA310388X		#6	2013	Yes
277 WEST END AVENUE	10023	CA068580N		#6	2013	Yes
277 WEST END AVENUE	10023	CA282972J		#6	2014	Yes
280 RIVERSIDE DRIVE	10025	CA084581P		#6	2014	Yes
285 RIVERSIDE DRIVE	10025	CA132179K		#6	2013	Yes
2861 BROADWAY	10025	CA005979R		#6	2013	
288 WEST 92 STREET	10025	CA209295K	DUAL FUEL	#4	2013	
29 WEST 64 STREET	10023	CA688686Z		#4	2013	
29 WEST 65 STREET	10023	CA096881P		#6	2013	
290 RIVERSIDE DRIVE	10025	CA261098J	DUAL FUEL	#6	2015	Yes
290 WEST END AVENUE	10023	CA015282X		#6	2013	Yes
299 RIVERSIDE DRIVE	10025	CA045676X		#6	2014	Yes
30 WEST 90 STREET	10024	CB539903K	DUAL FUEL	#4	2014	
300 CENTRAL PARK WEST	10024	CA172783N		#6	2014	Yes
300 CENTRAL PARK WEST	10024	CA311187Y		#6	2015	Yes
300 RIVERSIDE DRIVE	10025	CB110907L	DUAL FUEL	#6	2014	Yes
300 WEST 108 STREET	10025	CA104079P		#6	2013	Yes
300 WEST 109 STREET	10025	CB533403P	DUAL FUEL	#6	2014	Yes
302 WEST 86 STREET	10024	CA208794K		#6	2012	Yes
303 WEST 86 STREET	10024	CA018288K		#6	2012	Yes
304 WEST 75 STREET	10023	CA005383X		#6	2013	Yes
304 WEST 89 STREET	10024	CA309288K		#4	2013	
305 RIVERSIDE DRIVE	10025	CB502603Z	DUAL FUEL	#6	2014	Yes
305 WEST 72 STREET	10023	CA083278H		#6	2012	Yes
308 WEST 103 STREET	10025	CA152597L	DUAL FUEL	#6	2013	Yes
308 WEST 104 STREET	10025	CB216402Z	DUAL FUEL	#4	2012	Yes
309 WEST 104 STREET	10025	CA020689Y		#6	2014	Yes
310 RIVERSIDE DRIVE	10025	CA330692Z		#6	2014	Yes
310 WEST 72 STREET	10023	CA188469L		#6	2014	Yes
310 WEST 79 STREET	10024	CA104778Y		#6	2014	Yes
310 WEST 85 STREET	10024	CA065379H		#6	2013	
310 WEST 94 STREET	10025	CA015082L		#4	2012	
310 WEST END AVENUE	10023	CA031092P		#6	2013	Yes
314 WEST 100 STREET	10025	CA090172P		#4	2014	
315 CENTRAL PARK WEST	10025	CA136466L		#6	2014	Yes

315 CENTRAL PARK WEST	10025	CA064689Z		#6	2013	Yes
315 RIVERSIDE DRIVE	10025	CA057885K		#6	2015	Yes
315 WEST 98 STREET	10025	CA238894P		#4	2012	Yes
316 WEST 84 STREET	10024	CA190897K	DUAL FUEL	#6	2013	Yes
316 WEST 93 STREET	10025	CA081878M	DUAL FUEL	#4	2013	
317 WEST 87 STREET	10024	CA057980Z		#6	2013	
317 WEST 89 STREET	10024	CB175403M	DUAL FUEL	#4	2013	
318 WEST 100 STREET	10025	CA357586P		#4	2014	
32 WEST 82 STREET	10024	CA005686N		#6	2014	Yes
320 RIVERSIDE DRIVE	10025	CA274172L		#6	2014	Yes
320 WEST 76 STREET	10023	CA079483P		#6	2013	Yes
320 WEST 83 STREET	10024	CA425688H		#4	2013	
320 WEST 87 STREET	10024	CA003773M		#4	2014	Yes
320 WEST 87 STREET	10024	CB151501J	DUAL FUEL	#4	2014	Yes
320 WEST 89 STREET	10024	CA258791K		#4	2013	
320 WEST 90 STREET	10024	CA313985H		#4	2012	
320 WEST END AVENUE	10023	CA103579R		#6	2013	Yes
321 WEST 78 STREET	10024	CB088706J	DUAL FUEL	#6	2013	Yes
321 WEST 78 STREET	10024	CA391287Y		#6	2014	Yes
321 WEST 90 STREET	10024	CA230386M		#6	2014	
322 CENTRAL PARK WEST	10025	CA089179J	DUAL FUEL	#4	2013	Yes
322 CENTRAL PARK WEST	10025	CB433703M	DUAL FUEL	#4	2014	Yes
322 WEST 72 STREET	10023	CA193583L		#6	2013	Yes
324 WEST 84 STREET	10024	CB185903H	DUAL FUEL	#4	2013	
325 RIVERSIDE DRIVE	10025	CA020880M		#6	2013	Yes
325 WEST 71 STREET	10023	CA519285K		#4	2013	
325 WEST 77 STREET	10024	CA272671R		#6	2015	
325 WEST 77 STREET	10024	CA268099N	DUAL FUEL	#4	2015	
325 WEST 86 STREET	10024	CA190589Z		#6	2013	Yes
325 WEST END AVENUE	10023	CA031468Y		#6	2014	Yes
325 WEST END AVENUE	10023	CB024606H	DUAL FUEL	#6	2015	Yes
327 CENTRAL PARK WEST	10025	CB139306K	DUAL FUEL	#6	2012	Yes
328 WEST 86 STREET	10024	CA081189R		#6	2013	Yes
33 CENTRAL PARK WEST	10023	CA059178K		#6	2013	Yes
33 WEST 60 STREET	10023	CA101881Z		#6	2015	Yes
33 WEST 67 STREET	10023	CA500085X		#6	2013	Yes
330 WEST 72 STREET	10023	CA043781Z		#6	2014	Yes
333 CENTRAL PARK WEST	10025	CA025187R		#6	2014	Yes
333 WEST 85 STREET	10024	CA007491M		#4	2013	
333 WEST END AVENUE	10023	CA211571K		#6	2014	Yes
334 WEST 87 STREET	10024	CA079682H		#6	2012	
336 CENTRAL PARK WEST	10025	CB379100K	DUAL FUEL	#6	2014	Yes
336 CENTRAL PARK WEST	10025	CA063876J		#6	2015	Yes
336 WEST END AVENUE	10023	CA090878R		#6	2013	Yes

34 WEST 65 STREET	10023	CA218586P		#6	2015	
340 RIVERSIDE DRIVE	10025	CA353392Z		#6	2014	Yes
340 WEST 86 STREET	10024	CA240086J		#6	2014	Yes
344 WEST 72 STREET	10023	CA104980H		#6	2013	Yes
345 RIVERSIDE DRIVE	10025	CA294985R		#6	2012	Yes
345 WEST 88 STREET	10024	CA348890P		#4	2015	Yes
35 WEST 64 STREET	10023	CB214703H	DUAL FUEL	#6	2013	
35 WEST 81 STREET	10024	CA249588K		#6	2015	Yes
35 WEST 82 STREET	10024	CA186080Y	DUAL FUEL	#6	2015	
35 WEST 92 STREET	10025	CA137488R		#4	2015	Yes
350 CENTRAL PARK WEST	10025	CB084506R	DUAL FUEL	#6	2013	Yes
355 RIVERSIDE DRIVE	10025	CA129479P		#6	2013	Yes
36 WEST 84 STREET	10024	CA546286X		#6	2014	
360 CENTRAL PARK WEST	10025	CA298682H		#6	2013	Yes
360 CENTRAL PARK WEST	10025	CA064084X		#6	2014	Yes
360 RIVERSIDE DRIVE	10025	CA329189N		#6	2014	Yes
362 RIVERSIDE DRIVE	10025	CA231599K	DUAL FUEL	#6	2013	Yes
37 WEST 72 STREET	10023	CA273973R		#6	2014	Yes
37 WEST 93 STREET	10025	CA308083M		#6	2014	Yes
370 CENTRAL PARK WEST	10025	CA244092Y		#6	2014	Yes
370 RIVERSIDE DRIVE	10025	CB208105X	DUAL FUEL	#6	2014	Yes
372 CENTRAL PARK WEST	10025	CA084197K	DUAL FUEL	#6	2012	Yes
375 RIVERSIDE DRIVE	10025	CA098178M		#6	2015	Yes
380 RIVERSIDE DRIVE	10025	CA108980X		#6	2014	Yes
382 CENTRAL PARK WEST	10025	CA179890K		#6	2014	Yes
390 RIVERSIDE DRIVE	10025	CA180782L		#6	2014	Yes
392 CENTRAL PARK WEST	10025	CB298700M	DUAL FUEL	#6	2013	Yes
396 COLUMBUS AVENUE	10024	CA222284L		#6	2013	
4 WEST 90 STREET	10024	CA116156H		#4	2015	
40 WEST 67 STREET	10023	CB216801Z	DUAL FUEL	#6	2015	Yes
40 WEST 77 STREET	10024	CA056781L		#6	2015	Yes
40 WEST 77 STREET	10024	CB065001M	DUAL FUEL	#6	2014	Yes
40 WEST 86 STREET	10024	CB254100Z	DUAL FUEL	#6	2013	Yes
400 CENTRAL PARK WEST	10025	CA015778J		#6	2012	Yes
400 CENTRAL PARK WEST	10025	CB415803J	DUAL FUEL	#6	2012	Yes
400 RIVERSIDE DRIVE	10025	CA367672K		#6	2015	Yes
401 WEST END AVENUE	10024	CA000784Y		#6	2014	Yes
41 WEST 72 STREET	10023	CA003683Z		#6	2013	Yes
41 WEST 82 STREET	10024	CA168385X		#6	2012	Yes
41 WEST 83 STREET	10024	CA264389N		#6	2014	
41 WEST 86 STREET	10024	CB076208L	DUAL FUEL	#6	2015	Yes
41 WEST 96 STREET	10025	CA371370R		#4	2014	Yes
41 WEST 96 STREET	10025	CA084484N		#4	2013	Yes
411 WEST END AVENUE	10024	CA371085H		#6	2013	Yes

412 AMSTERDAM AVENUE	10024	CA284083Z		#4	2014	
412 WEST 110 STREET	10025	CA036378N		#6	2015	Yes
412 WEST END AVENUE	10024	CA266793Y		#4	2015	
415 CENTRAL PARK WEST	10025	CB563703N	DUAL FUEL	#6	2014	Yes
417 RIVERSIDE DRIVE	10025	CA296495N	DUAL FUEL	#4	2014	Yes
418 CENTRAL PARK WEST	10025	CA073588Y		#6	2015	Yes
420 CENTRAL PARK WEST	10025	CA438484Z		#6	2012	
420 WEST END AVENUE	10024	CA031174Z		#6	2014	Yes
424 WEST END AVENUE	10024	CA110981K		#6	2012	Yes
425 CENTRAL PARK WEST	10025	CA138797P	DUAL FUEL	#6	2013	
425 RIVERSIDE DRIVE	10025	CA256888H		#6	2013	Yes
435 CENTRAL PARK WEST	10025	CA142580X		#6	2012	Yes
435 CENTRAL PARK WEST	10025	CA245793L		#6	2014	Yes
435 RIVERSIDE DRIVE	10025	CA232688R		#4	2013	Yes
44 WEST 63 STREET	10023	CB183206K	DUAL FUEL	#6	2015	Yes
44 WEST 63 STREET	10023	CB126407J	DUAL FUEL	#6	2015	Yes
44 WEST 77 STREET	10024	CA114879M		#6	2013	Yes
440 WEST END AVENUE	10024	CA293585N		#6	2012	Yes
441 WEST END AVENUE	10024	CA001783R		#6	2013	Yes
444 CENTRAL PARK WEST	10025	CA063483Z		#6	2014	Yes
444 CENTRAL PARK WEST	10025	CA498385H		#6	2014	Yes
448 CENTRAL PARK WEST	10025	CB129808M	DUAL FUEL	#4	2013	
45 WEST 60 STREET	10023	CA199780H		#6	2015	Yes
45 WEST 67 STREET	10023	CA210684M		#6	2014	Yes
45 WEST 81 STREET	10024	CB401805Y	DUAL FUEL	#6	2015	Yes
46 WEST 83 STREET	10024	CA311086P		#4	2013	Yes
46 WEST 95 STREET	10025	CA535585M		#4	2015	
461 CENTRAL PARK WEST	10025	CA343195K	DUAL FUEL	#6	2014	Yes
465 WEST END AVENUE	10024	CA509485X		#6	2013	Yes
467 CENTRAL PARK WEST	10025	CA173080L	DUAL FUEL	#6	2013	Yes
47 MORNINGSIDE DRIVE	10025	CA035788L		#4	2012	
470 WEST END AVENUE	10024	CA288184X		#6	2014	Yes
473 CENTRAL PARK WEST	10025	CA106886K		#6	2014	
473 WEST END AVENUE	10024	CA212572R		#6	2012	Yes
477 CENTRAL PARK WEST	10025	CA321069M		#6	2015	
49 WEST 72 STREET	10023	CB400205X	DUAL FUEL	#6	2015	Yes
490 WEST END AVENUE	10024	CA214993Y		#6	2014	Yes
5 RIVERSIDE DRIVE	10023	CA024973J		#6	2015	Yes
5 RIVERSIDE DRIVE	10023	CB053701R	DUAL FUEL	#6	2013	Yes
5 WEST 86 STREET	10024	CA097181Z		#6	2015	Yes
50 CENTRAL PARK WEST	10023	CB000803K	DUAL FUEL	#6	2013	Yes
50 MANHATTAN AVENUE	10025	CA005379N		#6	2013	
50 MANHATTAN AVENUE	10025	CB141003J	DUAL FUEL	#6	2013	
50 MORNINGSIDE DRIVE	10025	CA141395J	DUAL FUEL	#4	2013	

50 RIVERSIDE DRIVE	10024	CA119679K		#6	2013	Yes
50 WEST 106 STREET	10025	CA277581X		#4	2015	
50 WEST 67 STREET	10023	CA197593N		#6	2014	Yes
50 WEST 72 STREET	10023	CA162080H		#6	2015	Yes
50 WEST 77 STREET	10024	CA015779L		#6	2012	Yes
50 WEST 77 STREET	10024	CB079405R	DUAL FUEL	#6	2014	Yes
50 WEST 93 STREET	10025	CB050308X	DUAL FUEL	#6	#N/A	Yes
50 WEST 97 STREET	10025	CB080407P	DUAL FUEL	#6	2014	Yes
500 WEST 110 STREET	10025	CA284285R		#4	2012	
500 WEST 111 STREET	10025	CA383485P		#6	2012	Yes
500 WEST END AVENUE	10024	CB406405R	DUAL FUEL	#6	2012	Yes
501 WEST 110 STREET	10025	CA349173R		#6	2012	Yes
504 WEST 110 STREET	10025	CA405287Z		#6	2014	Yes
504 WEST 110 STREET	10025	CB203407K	DUAL FUEL	#6	#N/A	Yes
505 WEST END AVENUE	10024	CA294486M		#6	2014	Yes
506 WEST 113 STREET	10025	CA242786J		#6	2013	
507 WEST 111 STREET	10025	CA024097Z	DUAL FUEL	#4	2012	
507/11 WEST 113 STREET	10025	CA227788H		#6	2013	
51 WEST 86 STREET	10024	CA093073N		#6	2015	Yes
511 WEST 112 STREET	10025	CA343186Z	DUAL FUEL	#4	2013	
514 WEST END AVENUE	10024	CA369292H		#6	2014	Yes
515 WEST END AVENUE	10024	CA342483K		#6	2014	Yes
518 WEST 111 STREET	10025	CA112387R		#6	2014	
52 RIVERSIDE DRIVE	10024	CA097375R		#6	2013	Yes
521 WEST 112 STREET	10025	CA206095M	DUAL FUEL	#6	2013	
522 WEST 112 STREET	10025	CA112087P	DUAL FUEL	#4	2015	
522 WEST END AVENUE	10024	CA114180Z	DUAL FUEL	#6	2013	Yes
523 WEST 112 STREET	10025	CA305484J		#6	2015	Yes
525 WEST END AVENUE	10024	CA134079M		#6	2014	Yes
527 WEST 110 STREET	10025	CA112080M		#6	2012	Yes
528 WEST 111 STREET	10025	CB117000M	DUAL FUEL	#6	2012	Yes
529 WEST 111 STREET	10025	CA006882P		#6	2015	
53 WEST 106 STREET	10025	CB488403X	DUAL FUEL	#4	2014	
53 WEST 106 STREET	10025	CA193993Y		#4	2014	
53 WEST 72 STREET	10023	CA089697J	DUAL FUEL	#4	2012	
530 WEST 112 STREET	10025	CA242286N		#6	2014	
530 WEST END AVENUE	10024	CA439584K		#6	2015	Yes
532 WEST 111 STREET	10025	CA183496Y	DUAL FUEL	#6	2014	Yes
533 WEST 112 STREET	10025	CA238099X	DUAL FUEL	#6	2012	Yes
535 WEST 110 STREET	10025	CA069880J	DUAL FUEL	#6	2013	Yes
535 WEST 111 STREET	10025	CA271082Y		#6	2013	
535 WEST 113 STREET	10025	CA280792N		#4	2014	

536 WEST 113 STREET	10025	CA280892K		#6	2014	Yes
539 WEST 112 STREET	10025	CA303589R		#6	2013	
54 WEST 74 STREET	10023	CA099286Y		#4	2013	Yes
541 WEST 113 STREET	10025	CA240588J		#6	2013	
544 WEST 114 STREET	10025	CA113487Z		#4	2013	
545 WEST 111 STREET	10025	CA145882P		#6	2013	Yes
545 WEST END AVENUE	10024	CA173270M		#6	2013	Yes
55 CENTRAL PARK WEST	10023	CA014980Z		#6	2014	Yes
55 CENTRAL PARK WEST	10023	CA181097H	DUAL FUEL	#6	2013	Yes
55 WEST 92 STREET	10025	CA068380Z		#6	2013	Yes
562 WEST END AVENUE	10024	CA036595J	DUAL FUEL	#6	2013	Yes
562 WEST END AVENUE	10024	CB056106Z	DUAL FUEL	#6	2012	Yes
565 WEST END AVENUE	10024	CA098997X	DUAL FUEL	#6	2012	Yes
565 WEST END AVENUE	10024	CA266973L		#6	2012	Yes
57 WEST 75 STREET	10023	CB192902M	DUAL FUEL	#6	2012	Yes
57 WEST 93 STREET	10025	CA024986Z		#6	2013	
574 WEST END AVENUE	10024	CB258001J	DUAL FUEL	#6	2014	Yes
575 WEST END AVENUE	10024	CB189507M	DUAL FUEL	#6	#N/A	Yes
58 WEST 72 STREET	10023	CA245389J		#4	2014	
580 WEST END AVENUE	10024	CA309384K		#6	2015	Yes
585 WEST END AVENUE	10024	CA198566M		#6	2012	Yes
588 WEST END AVENUE	10024	CA237290J		#6	2014	Yes
59 WEST 71 STREET	10023	CA350873X		#6	2013	Yes
590 WEST END AVENUE	10024	CA008584X		#6	2014	Yes
599 WEST END AVENUE	10024	CA360385X		#4	2014	
6 WEST 77 STREET	10024	CA194599K	DUAL FUEL	#6	2015	Yes
60 RIVERSIDE DRIVE	10024	CB089403X	DUAL FUEL	#6	2013	Yes
60 WEST 68 STREET	10023	CB246702R	DUAL FUEL	#6	2015	Yes
60 WEST 76 STREET	10023	CA123381J		#6	2014	Yes
600 COLUMBUS AVENUE	10024	CA378086L		#4	2012	Yes
600 WEST 111 STREET	10025	CA350686K		#6	2014	Yes
600 WEST 115 STREET	10025	CA125168J		#6	2015	Yes
600 WEST END AVENUE	10024	CA367369H		#6	2014	Yes
601 WEST 110 STREET	10025	CA318888Z		#4	2013	Yes
601 WEST 110 STREET	10025	CA225484J		#4	2014	Yes
601 WEST 113 STREET	10025	CB016902P	DUAL FUEL	#6	#N/A	Yes
604 WEST 115 STREET	10025	CA123388M		#4	2015	
607 WEST END AVENUE	10024	CB197600H	DUAL FUEL	#4	2013	Yes
609 WEST 114 STREET	10025	CA334185M		#6	2012	Yes
61 WEST 62 STREET	10023	CA133579Y		#6	2015	Yes
610 WEST 110 STREET	10025	CA018579K		#6	2012	Yes
610 WEST 113 STREET	10025	CA242586P		#4	2014	
610 WEST END AVENUE	10024	CA223983P		#6	2013	Yes
611 WEST 111 STREET	10025	CA186396K	DUAL FUEL	#6	2014	Yes

611 WEST 112 STREET	10025	CA355986P		#4	2014	
615 WEST 113 STREET	10025	CA073480M		#4	2014	
63 WEST 107 STREET	10025	CA032489H		#4	#N/A	
639 WEST END AVENUE	10025	CB009102M	DUAL FUEL	#6	2013	Yes
640 WEST END AVENUE	10024	CA228691X		#6	2012	Yes
645 WEST END AVENUE	10025	CA283273P		#6	2014	Yes
65 WEST 95 STREET	10025	CB138308R	DUAL FUEL	#6	2015	Yes
650 WEST END AVENUE	10025	CA285373L		#6	2012	Yes
66 WEST 88 STREET	10024	CB222803M	DUAL FUEL	#4	2014	
666 WEST END AVENUE	10025	CA288485J		#4	2013	Yes
666 WEST END AVENUE	10025	CA255295H	DUAL FUEL	#4	2014	Yes
67 RIVERSIDE DRIVE	10024	CB163503H	DUAL FUEL	#4	2013	Yes
670 WEST END AVENUE	10025	CA155990L		#6	2014	Yes
677 WEST END AVENUE	10025	CA303195Y	DUAL FUEL	#6	2014	Yes
685 WEST END AVENUE	10025	CA344093Y		#6	2012	Yes
697 WEST END AVENUE	10025	CA096276R		#6	2012	Yes
698 WEST END AVENUE	10025	CA390186K		#6	2014	Yes
7 WEST 96 STREET	10025	CA097277N		#6	2013	Yes
70 RIVERSIDE DRIVE	10024	CB085200P	DUAL FUEL	#6	2013	Yes
70 WEST 95 STREET	10025	CA049296M	DUAL FUEL	#6	2013	Yes
710 WEST END AVENUE	10025	CA205684X		#6	2014	Yes
711 WEST END AVENUE	10025	CA183399M	DUAL FUEL	#6	2015	Yes
720 WEST END AVENUE	10025	CA423287H		#4	2015	Yes
720 WEST END AVENUE	10025	CA423187K		#4	2013	Yes
733 AMSTERDAM AVENUE	10025	CB446703Y	DUAL FUEL	#4	2014	Yes
736 WEST END AVENUE	10025	CB570303H	DUAL FUEL	#6	2014	
74 WEST 68 STREET	10023	CB464203Y	DUAL FUEL	#4	2014	Yes
740 WEST END AVENUE	10025	CA999973J		#4	2015	Yes
740 WEST END AVENUE	10025	CA152895J	DUAL FUEL	#4	2013	Yes
75 CENTRAL PARK WEST	10023	CA007396Y	DUAL FUEL	#6	2014	Yes
750 COLUMBUS AVENUE	10025	CA687986X		#6	2015	Yes
755 WEST END AVENUE	10025	CB166006M	DUAL FUEL	#6	2013	Yes
760 WEST END AVENUE	10025	CA163587L		#6	2014	Yes
77 WEST 85 STREET	10024	CA288285P		#6	2013	
771 WEST END AVENUE	10025	CA145473Y		#6	2014	Yes
78 MANHATTAN AVENUE	10025	CA002482H		#6	2015	
784 COLUMBUS AVENUE	10025	CA094267X		#6	2013	Yes
784 COLUMBUS AVENUE	10025	CB228802Y	DUAL FUEL	#6	2013	Yes
785 WEST END AVENUE	10025	CA286092J		#6	2013	Yes
788 COLUMBUS AVENUE	10025	CB220702N	DUAL FUEL	#6	2013	Yes
789 WEST END AVENUE	10025	CA052777K		#6	2013	Yes
792 COLUMBUS AVENUE	10025	CB228902M	DUAL FUEL	#6	2013	Yes
800 WEST END AVENUE	10025	CA177880H		#6	2012	Yes
801 WEST END AVENUE	10025	CA006896X	DUAL FUEL	#6	2015	Yes

808 WEST END AVENUE	10025	CA146282X		#6	2013	Yes
817 WEST END AVENUE	10025	CA248888H		#6	2012	
838 WEST END AVENUE	10025	CB247702X	DUAL FUEL	#6	2015	Yes
838 WEST END AVENUE	10025	CA126996J	DUAL FUEL	#6	2015	Yes
839 WEST END AVENUE	10025	CA207381H		#6	2014	Yes
840 WEST END AVENUE	10025	CA109698R	DUAL FUEL	#6	2013	
850 AMSTERDAM AVENUE	10025	CA099780J		#6	2013	Yes
850 WEST END AVENUE	10025	CA484785J	DUAL FUEL	#4	2013	
875 WEST END AVENUE	10025	CA044187K		#6	2014	Yes
88 CENTRAL PARK WEST	10023	CA198066X		#6	2012	Yes
884 WEST END AVENUE	10025	CA007770P		#6	2015	Yes
885 WEST END AVENUE	10025	CB288200R	DUAL FUEL	#6	2013	Yes
890 WEST END AVENUE	10025	CA053471M		#6	2014	Yes
895 WEST END AVENUE	10025	CA322686M		#6	2013	Yes
9 WEST 64 STREET	10023	CA140697K	DUAL FUEL	#4	2012	
90 RIVERSIDE DRIVE	10024	CA245471Z		#6	2014	Yes
90 RIVERSIDE DRIVE	10024	CA022495P	DUAL FUEL	#6	2014	Yes
900 WEST END AVENUE	10025	CA005079L		#6	2014	Yes
905 WEST END AVENUE	10025	CB268800R	DUAL FUEL	#6	2013	Yes
905 WEST END AVENUE	10025	CA030979L		#6	2013	Yes
910 WEST END AVENUE	10025	CA058885P		#6	2012	Yes
915 WEST END AVENUE	10025	CA330486H		#6	2013	Yes
924 WEST END AVENUE	10025	CA258683N		#6	2013	Yes
929 WEST END AVENUE	10025	CA123181P		#6	2014	
945 WEST END AVENUE	10025	CA157883P		#6	2013	Yes
949 WEST END AVENUE	10025	CA147672X		#6	2014	Yes
98 RIVERSIDE DRIVE	10024	CB082505X	DUAL FUEL	#6	2015	Yes

Appendix C: List of Buildings in Area of Study and Relevant Greener Greater Buildings Plan Information[15]

ADDRESS	ZIPCODE	DEP APPLICATION #	#6 PHASE-OUT DEADLINE	AUDIT / RETROCOMMISSIONING DEADLINE
1 WEST 64 STREET	10023	CA305384M	2012	2017
1 WEST 72 STREET	10023	CA052577X	2012	2015
1 WEST 85 STREET	10024	CA180192L	2013	2019
100 RIVERSIDE DRIVE	10024	CA106569R	2013	2015
100 RIVERSIDE DRIVE	10024	CB013301X	2014	2015
101 CENTRAL PARK WEST	10023	CA003281X	2015	2013
101 CENTRAL PARK WEST	10023	CA077987J	2014	2013
102 WEST 85 STREET	10024	CA558585Y	2013	2015
107 WEST 86 STREET	10024	CA204497X	2013	2017
11 RIVERSIDE DRIVE	10023	CB201600J	2013	2014
110 WEST 94 STREET	10025	CA122487N	2014	2014
116 WEST 72 STREET	10023	CA122398L	2013	2013
118 WEST 79 STREET	10024	CA288087Y	2014	2020
12 WEST 96 STREET	10025	CA011284L	2015	2019
121 WEST 72 STREET	10023	CA108297L	2013	2014
123 WEST 93 STREET	10025	CA083387R	2014	2014
127 WEST 79 STREET	10024	CA052280P	2013	2020
130 WEST 86 STREET	10024	CA285783Y	2013	2016
131 RIVERSIDE DRIVE	10024	CA359984J	2014	2017
137 RIVERSIDE DRIVE	10024	CA489486M	2014	2017
139 WEST 82 STREET	10024	CA004891H	2012	2013
140 RIVERSIDE DRIVE	10024	CA031899X	2014	2018
145 CENTRAL PARK WEST	10023	CA139183P	2015	2017
145 CENTRAL PARK WEST	10023	CA042184X	2014	2017
15 WEST 67 STREET	10023	CA580786L	2014	2020
15 WEST 81 STREET	10024	CA147282K	2013	2015
15 WEST 84 STREET	10024	CA281192Y	2014	2018
150 WEST 87 STREET	10024	CB158302J	2015	2017
151 CENTRAL PARK WEST	10023	CA332170K	2013	2018
151 CENTRAL PARK WEST	10023	CA167296J	2014	2018
157 WEST 79 STREET	10024	CA233199K	2015	2020

[15] As of April 2012. Database can be downloaded at: https://nycopendata.socrata.com/Facilities-and-Structures/Oil-Boilers-Detailed-Fuel-Consumption-and-Building/jfzu-yy6n

160 RIVERSIDE DRIVE	10024	CB083508N	2015	2020
160 WEST 87 STREET	10024	CA260288X	2013	2017
161 WEST 86 STREET	10024	CA054177X	2015	2017
164 WEST 79 STREET	10024	CA057880L	2014	2020
165 WEST 66 STREET	10023	CA065176H	2015	2018
17 WEST 71 STREET	10023	CA125078X	2014	2014
171 WEST 71 STREET	10023	CA310872H	2015	2013
171 WEST 79 STREET	10024	CA280086X	2014	2020
173 /175 WEST 93 STREET	10025	CA061778R	2013	2014
175 WEST 73 STREET	10023	CA235185Z	2013	2015
175 WEST 73 STREET	10023	CA235285X	2013	2015
175 WEST 93 STREET	10025	CA394090Y	2015	2014
176 WEST 87 STREET	10024	CA314585N	2013	2017
18 WEST 70 STREET	10023	CA302693M	2015	2022
186 RIVERSIDE DRIVE	10024	CB086806J	2012	2021
194 RIVERSIDE DRIVE	10025	CA105873R	2012	2021
2 WEST 67 STREET	10023	CA220795Y	2013	2019
200 WEST 108 STREET	10025	CA288385M	2012	2019
200 WEST 86 STREET	10024	CA007980N	2015	2013
200 WEST 86 STREET	10024	CA079583M	2013	2013
201 WEST 89 STREET	10024	CA130172Z	2013	2017
205 WEST 89 STREET	10024	CA120297N	2012	2017
210 RIVERSIDE DRIVE	10025	CA123281M	2015	2022
211 CENTRAL PARK WEST	10024	CB261401N	2014	2015
211 CENTRAL PARK WEST	10024	CB245002K	2012	2015
212 WEST 85 STREET	10024	CA192296Y	2015	2022
215 WEST 78 STREET	10024	CA045776N	2012	2020
215 WEST 91 STREET	10024	CB566703K	2014	2019
215 WEST 92 STREET	10025	CB311100K	2013	2020
2166 BROADWAY	10024	CA174481R	2015	2018
225 CENTRAL PARK WEST	10024	CA118577P	2013	2016
225 CENTRAL PARK WEST	10024	CB188607L	2014	2016
23 WEST 73 STREET	10023	CA021596J	2014	2016
23 WEST 73 STREET	10023	CB042703Z	2012	2016
230 WEST END AVENUE	10023	CA147382H	2012	2022
238 WEST 106 STREET	10025	CA252783N	2014	2017
239 CENTRAL PARK WEST	10024	CB001003Y	2014	2017
243 WEST 70 STREET	10023	CA124978R	2012	2022
243 WEST END AVENUE	10023	CA264482H	2013	2013
245 WEST 104 STREET	10025	CA037778R	2015	2016
245 WEST 107 STREET	10025	CA367572N	2015	2019
245 WEST 74 STREET	10023	CA096981M	2014	2016
250 WEST 94 STREET	10025	CA397784M	2015	2021
252 WEST 85 STREET	10024	CA191181J	2012	2022

255 WEST 108 STREET	10025	CA319193R	2015	2020
255 WEST 90 STREET	10024	CA046198P	2013	2018
255 WEST END AVENUE	10023	CA519385H	2013	2013
257 CENTRAL PARK WEST	10024	CB400305Y	2015	2019
258 RIVERSIDE DRIVE	10025	CA207396K	2015	2017
260 WEST END AVENUE	10023	CA199896J	2014	2013
262 CENTRAL PARK WEST	10024	CA348088H	2013	2020
265 RIVERSIDE DRIVE	10025	CA069773Y	2014	2018
27 WEST 67 STREET	10023	CA121284Z	2014	2020
277 WEST END AVENUE	10023	CA282972J	2014	2014
277 WEST END AVENUE	10023	CA068580N	2013	2014
285 RIVERSIDE DRIVE	10025	CA132179K	2013	2019
290 WEST END AVENUE	10023	CA015282X	2013	2015
299 RIVERSIDE DRIVE	10025	CA045676X	2014	2019
300 CENTRAL PARK WEST	10024	CA172783N	2014	2014
300 CENTRAL PARK WEST	10024	CA311187Y	2015	2014
300 RIVERSIDE DRIVE	10025	CB110907L	2014	2020
300 WEST 108 STREET	10025	CA104079P	2013	2022
302 WEST 86 STREET	10024	CA208794K	2012	2017
303 WEST 86 STREET	10024	CA018288K	2012	2018
304 WEST 75 STREET	10023	CA005383X	2013	2014
305 WEST 72 STREET	10023	CA083278H	2012	2014
308 WEST 103 STREET	10025	CA152597L	2013	2020
309 WEST 104 STREET	10025	CA020689Y	2014	2021
310 RIVERSIDE DRIVE	10025	CA330692Z	2014	2020
310 WEST 72 STREET	10023	CA188469L	2014	2013
310 WEST 79 STREET	10024	CA104778Y	2014	2016
310 WEST END AVENUE	10023	CA031092P	2013	2016
315 RIVERSIDE DRIVE	10025	CA057885K	2015	2020
316 WEST 84 STREET	10024	CA190897K	2013	2015
32 WEST 82 STREET	10024	CA005686N	2014	2015
320 RIVERSIDE DRIVE	10025	CA274172L	2014	2021
320 WEST 76 STREET	10023	CA079483P	2013	2015
320 WEST END AVENUE	10023	CA103579R	2013	2017
321 WEST 78 STREET	10024	CA391287Y	2014	2016
321 WEST 78 STREET	10024	CB088706J	2013	2016
322 WEST 72 STREET	10023	CA193583L	2013	2013
325 RIVERSIDE DRIVE	10025	CA020880M	2013	2021
325 WEST 86 STREET	10024	CA190589Z	2013	2018
325 WEST END AVENUE	10023	CA031468Y	2014	2015
325 WEST END AVENUE	10023	CB024606H	2015	2015
328 WEST 86 STREET	10024	CA081189R	2013	2017
33 WEST 67 STREET	10023	CA500085X	2013	2020
330 WEST 72 STREET	10023	CA043781Z	2014	2013

333 CENTRAL PARK WEST	10025	CA025187R	2014	2017
333 WEST END AVENUE	10023	CA211571K	2014	2015
336 CENTRAL PARK WEST	10025	CA063876J	2015	2017
336 CENTRAL PARK WEST	10025	CB379100K	2014	2017
336 WEST END AVENUE	10023	CA090878R	2013	2017
340 RIVERSIDE DRIVE	10025	CA353392Z	2014	2022
345 RIVERSIDE DRIVE	10025	CA294985R	2012	2022
35 WEST 81 STREET	10024	CA249588K	2015	2015
355 RIVERSIDE DRIVE	10025	CA129479P	2013	2022
360 RIVERSIDE DRIVE	10025	CA329189N	2014	2013
37 WEST 93 STREET	10025	CA308083M	2014	2017
370 CENTRAL PARK WEST	10025	CA244092Y	2014	2022
370 RIVERSIDE DRIVE	10025	CB208105X	2014	2013
375 RIVERSIDE DRIVE	10025	CA098178M	2015	2013
380 RIVERSIDE DRIVE	10025	CA108980X	2014	2014
390 RIVERSIDE DRIVE	10025	CA180782L	2014	2014
40 WEST 67 STREET	10023	CB216801Z	2015	2019
40 WEST 77 STREET	10024	CA056781L	2015	2019
40 WEST 77 STREET	10024	CB065001M	2014	2019
400 RIVERSIDE DRIVE	10025	CA367672K	2015	2015
401 WEST END AVENUE	10024	CA000784Y	2014	2014
41 WEST 82 STREET	10024	CA168385X	2012	2016
411 WEST END AVENUE	10024	CA371085H	2013	2014
415 CENTRAL PARK WEST	10025	CB563703N	2014	2017
44 WEST 77 STREET	10024	CA114879M	2013	2019
440 WEST END AVENUE	10024	CA293585N	2012	2019
444 CENTRAL PARK WEST	10025	CA063483Z	2014	2020
444 CENTRAL PARK WEST	10025	CA498385H	2014	2020
465 WEST END AVENUE	10024	CA509485X	2013	2015
470 WEST END AVENUE	10024	CA288184X	2014	2020
473 WEST END AVENUE	10024	CA212572R	2012	2015
49 WEST 72 STREET	10023	CB400205X	2015	2015
490 WEST END AVENUE	10024	CA214993Y	2014	2021
5 RIVERSIDE DRIVE	10023	CA024973J	2015	2014
5 RIVERSIDE DRIVE	10023	CB053701R	2013	2014
50 CENTRAL PARK WEST	10023	CB000803K	2013	2017
50 RIVERSIDE DRIVE	10024	CA119679K	2013	2016
50 WEST 67 STREET	10023	CA197593N	2014	2019
500 WEST 111 STREET	10025	CA383485P	2012	2022
505 WEST END AVENUE	10024	CA294486M	2014	2016
514 WEST END AVENUE	10024	CA369292H	2014	2022
515 WEST END AVENUE	10024	CA342483K	2014	2016
52 RIVERSIDE DRIVE	10024	CA097375R	2013	2016
522 WEST END AVENUE	10024	CA114180Z	2013	2013

528 WEST 111 STREET	10025	CB117000M	2012	2022
532 WEST 111 STREET	10025	CA183496Y	2014	2022
535 WEST 110 STREET	10025	CA069880J	2013	2022
545 WEST END AVENUE	10024	CA173270M	2013	2018
55 CENTRAL PARK WEST	10023	CA014980Z	2014	2018
55 CENTRAL PARK WEST	10023	CA181097H	2013	2018
562 WEST END AVENUE	10024	CA036595J	2013	2015
562 WEST END AVENUE	10024	CB056106Z	2012	2015
565 WEST END AVENUE	10024	CA266973L	2012	2019
565 WEST END AVENUE	10024	CA098997X	2012	2019
588 WEST END AVENUE	10024	CA237290J	2014	2016
59 WEST 71 STREET	10023	CA350873X	2013	2014
590 WEST END AVENUE	10024	CA008584X	2014	2016
6 WEST 77 STREET	10024	CA194599K	2015	2019
60 WEST 68 STREET	10023	CB246702R	2015	2020
600 WEST END AVENUE	10024	CA367369H	2014	2017
609 WEST 114 STREET	10025	CA334185M	2012	2016
610 WEST END AVENUE	10024	CA223983P	2013	2017
611 WEST 111 STREET	10025	CA186396K	2014	2014
639 WEST END AVENUE	10025	CB009102M	2013	2021
645 WEST END AVENUE	10025	CA283273P	2014	2021
65 WEST 95 STREET	10025	CB138308R	2015	2019
670 WEST END AVENUE	10025	CA155990L	2014	2020
677 WEST END AVENUE	10025	CA303195Y	2014	2022
685 WEST END AVENUE	10025	CA344093Y	2012	2022
7 WEST 96 STREET	10025	CA097277N	2013	2022
70 RIVERSIDE DRIVE	10024	CB085200P	2013	2014
710 WEST END AVENUE	10025	CA205684X	2014	2022
75 CENTRAL PARK WEST	10023	CA007396Y	2014	2020
755 WEST END AVENUE	10025	CB166006M	2013	2017
760 WEST END AVENUE	10025	CA163587L	2014	2019
771 WEST END AVENUE	10025	CA145473Y	2014	2017
789 WEST END AVENUE	10025	CA052777K	2013	2018
800 WEST END AVENUE	10025	CA177880H	2012	2020
801 WEST END AVENUE	10025	CA006896X	2015	2018
839 WEST END AVENUE	10025	CA207381H	2014	2019
875 WEST END AVENUE	10025	CA044187K	2014	2020
88 CENTRAL PARK WEST	10023	CA198066X	2012	2021
885 WEST END AVENUE	10025	CB288200R	2013	2020
890 WEST END AVENUE	10025	CA053471M	2014	2015
895 WEST END AVENUE	10025	CA322686M	2013	2020
90 RIVERSIDE DRIVE	10024	CA245471Z	2014	2014
90 RIVERSIDE DRIVE	10024	CA022495P	2014	2014
924 WEST END AVENUE	10025	CA258683N	2013	2017

Appendix D: Detailed Boiler Information for Buildings in Area of Study[16]

ADDRESS	BOILER MODEL	DUAL FUEL?	# OF IDENTICAL BOILERS	BOILER CAPACITY (mmBTU/hour)	GROSS CAPACITY	SITE BOILER CAPACITY	BOILER INSTALL DATE	EST. RETIRE DATE
1 WEST 64 STREET	ROCKMILLS MODEL MP-200		1	8.50	8.50	8.50	1984	2019
1 WEST 72 STREET	ROCKMILLS MP 300		1	12.60	12.60	12.60	1977	2012
1 WEST 85 STREET	ROCKMILLS MP-250 (EXG)		1	10.36	10.36	10.36	1992	2027
100 RIVERSIDE DRIVE	KEWANEE #1786		2	12.60	25.20	40.69	1969	2010
100 RIVERSIDE DRIVE	KEWANEE 1786	DUAL FUEL	2	7.75	15.49		2001	2036
101 CENTRAL PARK WEST	ROCKMILLS MP 450		1	18.90	18.90	37.80	1981	2016
101 CENTRAL PARK WEST	ROCKMILLS MP 450 (RIGHT HAND BOILER)		1	18.90	18.90		1987	2022
102 WEST 85 STREET	FEDERAL FST-125		1	5.20	5.20	5.20	1985	2020
107 WEST 86 STREET	ROCKMILLS MP-250	DUAL FUEL	2	10.36	20.72	20.72	1997	2032
11 RIVERSIDE DRIVE	BEST 5E-350	DUAL FUEL	3	14.70	44.10	44.10	2000	2035
110 WEST 94 STREET	FEDERAL FST 80		1	3.10	3.10	3.10	1987	2022
116 WEST 72 STREET	FEDERAL FST-125	DUAL FUEL	1	5.30	5.30	5.30	1998	2033
118 WEST 79 STREET	ROCKMILLS MP 150		1	6.00	6.00	6.00	1987	2022
12 WEST 96 STREET	FEDERAL MODEL FST-200		1	8.50	8.50	8.50	1984	2019
121 WEST 72 STREET	FEDERAL FST-100	DUAL FUEL	1	4.20	4.20	4.20	1997	2032
123 WEST 93 STREET	FEDERAL FST 200 SP		1	8.20	8.20	8.20	1987	2022
127 WEST 79 STREET	ROCKMILLS MP 250		1	10.40	10.40	10.40	1980	2015
130 WEST 86 STREET	FEDERAL FST 125		1	4.90	4.90	4.90	1983	2018
131 RIVERSIDE DRIVE	FEDERAL FST-125		1	4.80	4.80	4.80	1984	2019
137 RIVERSIDE DRIVE	FEDERAL FST-200		1	7.77	7.77	7.77	1986	2021
139 WEST 82 STREET	FEDERAL FST 150		1	5.80	5.80	5.80	1991	2026
140 RIVERSIDE DRIVE	ROCKMILLS MP-500	DUAL FUEL	1	19.99	19.99	19.99	1999	2034
145 CENTRAL PARK WEST	ROCKMILLS MP 350		2	14.70	29.40	35.70	1983	2018
145 CENTRAL PARK WEST	ROCKMILLS-MP-150		1	6.30	6.30		1984	2019
15 WEST 67 STREET	FEDERAL FST 125		1	5.25	5.25	5.25	1986	2021

[16] As of April 2012. Database can be downloaded at: https://nycopendata.socrata.com/Facilities-and-Structures/Oil-Boilers-Detailed-Fuel-Consumption-and-Building/jfzu-yy6n

15 WEST 81 STREET	FEDERAL FST - 200		2	8.20	16.40	16.40	1982	2017
15 WEST 84 STREET	ROCKMILLS MP 150		1	6.27	6.27	6.27	1992	2027
150 WEST 87 STREET	EASTMOND/FEDERAL FST-90	DUAL FUEL	1	3.78	3.78	3.78	2002	2037
151 CENTRAL PARK WEST	FEDERAL FLW 1822		1	7.80	7.80	14.52	1970	2010
151 CENTRAL PARK WEST	FEDERAL FST 175	DUAL FUEL	1	6.72	6.72		1996	2031
157 WEST 79 STREET	FEDERAL FLW 1215	DUAL FUEL	1	5.30	5.30	5.30	1999	2034
160 RIVERSIDE DRIVE	ROCKMILLS MP - 250 (EXSTG)	DUAL FUEL	1	8.30	8.30	8.30	2008	2043
160 WEST 87 STREET	FEDERAL FST 100		1	4.20	4.20	4.20	1988	2023
161 WEST 86 STREET	ROCKMILLS MP-200		1	8.50	8.50	8.50	1977	2012
164 WEST 79 STREET	ROCKMILLS MP4-162		1	6.40	6.40	6.40	1980	2015
165 WEST 66 STREET	ROCKMILLS MP 300		2	12.60	25.20	25.20	1976	2011
17 WEST 71 STREET	FEDERAL FST-100		1	4.74	4.74	4.74	1978	2013
171 WEST 71 STREET	FEDERAL FST-200 (SP)		1	6.69	6.69	6.69	1972	2010
171 WEST 79 STREET	ROCKMILLS MP 175		1	7.35	7.35	7.35	1986	2021
173 /175 WEST 93 STREET	FEDERAL FST-300		1	10.00	10.00	10.00	1978	2013
175 WEST 73 STREET	SPENCER 4F1323 4SLB		1	12.30	12.30	23.50	1985	2020
175 WEST 73 STREET	FEDERAL PLW 265		1	11.20	11.20		1985	2020
175 WEST 93 STREET	FEDERAL FST 250		1	9.95	9.95	9.95	1990	2025
176 WEST 87 STREET	FEDERAL FST 250		1	8.90	8.90	8.90	1985	2020
18 WEST 70 STREET	ROCKMILLS MP-100		1	4.20	4.20	4.20	1993	2028
186 RIVERSIDE DRIVE	BEST 5C-200	DUAL FUEL	1	6.60	6.60	6.60	2006	2041
194 RIVERSIDE DRIVE	ROCKMILLS MP 150		1	6.30	6.30	6.30	1973	2010
2 WEST 67 STREET	FEDERAL FST-150	DUAL FUEL	2	6.27	12.54	12.54	1995	2030
200 WEST 108 STREET	FEDERAL FST-200		1	8.20	8.20	8.20	1985	2020
200 WEST 86 STREET	ROCKMILLS MP 450		1	16.90	16.90	33.80	1980	2015
200 WEST 86 STREET	ROCKMILLS MP 450		1	16.90	16.90		1983	2018
201 WEST 89 STREET	ROCKMILLS MP-300		1	11.80	11.80	11.80	1972	2010
205 WEST 89 STREET	FEDERAL/EASTMOND FST-400	DUAL FUEL	1	16.47	16.47	16.47	1997	2032
210 RIVERSIDE DRIVE	FEDERAL FMR2429		1	8.40	8.40	8.40	1981	2016
211 CENTRAL PARK WEST	FEDERAL FST-350	DUAL FUEL	1	14.70	14.70	38.13	2001	2036
211 CENTRAL PARK WEST	FEDERAL/EASTMOND (EXSTG) FST-350	DUAL FUEL	2	11.72	23.43		2002	2037
212 WEST 85 STREET	ROCKMILLS MP-90	DUAL FUEL	1	3.80	3.80	3.80	1996	2031
215 WEST 78 STREET	ROCKMILLS MP 100		1	4.20	4.20	4.20	1976	2011
215 WEST 91 STREET	(EXISTING) ROCKMILLS MP 250	DUAL FUEL	1	8.36	8.36	8.36	2003	2038
215 WEST 92 STREET	EXISTING-ROCKMILLS-MP 250	DUAL FUEL	1	10.50	10.50	10.50	2000	2035

2166 BROADWAY	ROCKMILLS MP4-351	DUAL FUEL	1	14.77	14.77	14.77	1981	2016
225 CENTRAL PARK WEST	PACIFIC 229		1	14.53	14.53	26.23	1977	2012
225 CENTRAL PARK WEST	FEDERAL FST - 350 (NEW)	DUAL FUEL	1	11.70	11.70		2007	2042
23 WEST 73 STREET	EASTMOND/FEDERAL FST-350	DUAL FUEL	1	14.00	14.00	27.39	1996	2031
23 WEST 73 STREET	ROCKMILLS MP-400 (EXTG)	DUAL FUEL	1	13.39	13.39		2003	2038
230 WEST END AVENUE	HEGGIE SIMPLEX #323		1	7.30	7.30	7.30	1982	2017
238 WEST 106 STREET	FEDERAL FST-125		1	4.40	4.40	4.40	1983	2018
239 CENTRAL PARK WEST	FEDERAL / EASTMOND- ESP-200	DUAL FUEL	2	6.70	13.39	13.39	2003	2038
243 WEST 70 STREET	FEDERAL FST-100		1	4.20	4.20	4.20	1978	2013
243 WEST END AVENUE	ROCKMILLS MP 4212		1	7.80	7.80	7.80	1982	2017
245 WEST 104 STREET	ROCKMILLS MP-200		1	8.20	8.20	8.20	1978	2013
245 WEST 107 STREET	ROCKMILLS MP 350		1	13.75	13.75	13.75	1972	2010
245 WEST 74 STREET	FEDERAL FST 150		1	6.20	6.20	6.20	1981	2016
250 WEST 94 STREET	ROCKMILLS MP-350		1	14.70	14.70	14.70	1984	2019
252 WEST 85 STREET	FEDERAL (EASTMOND) MODEL FST-100		1	4.20	4.20	4.20	1981	2016
255 WEST 108 STREET	ROCKMILLS MP-250		1	9.55	9.55	9.55	1993	2028
255 WEST 90 STREET	FEDERAL FST-175	DUAL FUEL	1	7.40	7.40	7.40	1998	2033
255 WEST END AVENUE	ROCKMILLS M P 150		1	6.30	6.30	6.30	1985	2020
257 CENTRAL PARK WEST	BEST 5D-200 (NEW)	DUAL FUEL	1	6.60	6.60	6.60	2005	2040
258 RIVERSIDE DRIVE	FEDERAL FST-150	DUAL FUEL	1	6.30	6.30	6.30	1996	2031
260 WEST END AVENUE	FEDERAL FST-150	DUAL FUEL	1	5.95	5.95	5.95	1996	2031
262 CENTRAL PARK WEST	ROCKMILLS MP 250		2	10.08	20.16	20.16	1988	2023
265 RIVERSIDE DRIVE	ROCKMILLS MP125		1	4.90	4.90	4.90	1973	2010
27 WEST 67 STREET	ROCKMILLS MP 100-SL		1	4.20	4.20	4.20	1984	2019
277 WEST END AVENUE	FEDERAL FMA KD3036		1	8.99	8.99	22.52	1972	2010
277 WEST END AVENUE	FEDERAL FST-300		1	13.53	13.53		1980	2015
285 RIVERSIDE DRIVE	ROCKMILLS MP-250		1	10.40	10.40	10.40	1979	2014
290 WEST END AVENUE	FEDERAL FST-200		1	8.40	8.40	8.40	1982	2017
299 RIVERSIDE DRIVE	ROCKMILL MP150		1	5.30	5.30	5.30	1976	2011
300 CENTRAL PARK WEST	ROCKMILLS MP 600		1	21.00	21.00	42.00	1983	2018
300 CENTRAL PARK WEST	ROCKMILLS MP 500		1	21.00	21.00		1987	2022
300 RIVERSIDE DRIVE	FEDERAL FST - 250 (NEW)	DUAL FUEL	1	8.30	8.30	8.30	2007	2042
300 WEST 108 STREET	ROCKMILLS MP-200		1	8.40	8.40	8.40	1979	2014
302 WEST 86 STREET	ROCKMILLS MP-100		1	4.20	4.20	4.20	1994	2029

303 WEST 86 STREET	FEDERAL FST 125		1	4.30	4.30	4.30	1988	2023
304 WEST 75 STREET	ROCKMILLS MP-200		1	8.40	8.40	8.40	1983	2018
305 WEST 72 STREET	BURNHAM 4F-563-50		1	4.60	4.60	4.60	1978	2013
308 WEST 103 STREET	FEDERAL FST-100	DUAL FUEL	1	3.79	3.79	3.79	1997	2032
309 WEST 104 STREET	FEDERAL FST-100		1	4.20	4.20	4.20	1989	2024
310 RIVERSIDE DRIVE	ROCKMILLS MP-350 (EXG)		2	13.48	26.96	26.96	1992	2027
310 WEST 72 STREET	ROCKMILLS MP-175		2	6.00	12.00	12.00	1969	2010
310 WEST 79 STREET	ROCKMILLS MP-100		1	4.20	4.20	4.20	1978	2013
310 WEST END AVENUE	ROCKMILLS MP-150		1	6.72	6.72	6.72	1992	2027
315 RIVERSIDE DRIVE	FEDERAL FST 200		1	7.40	7.40	7.40	1985	2020
316 WEST 84 STREET	FEDERAL/EASTMOND FST-80	DUAL FUEL	1	3.14	3.14	3.14	1997	2032
32 WEST 82 STREET	ROCKMILLS MP80		1	3.10	3.10	3.10	1986	2021
320 RIVERSIDE DRIVE	ROCKMILLS MP 300		1	11.80	11.80	11.80	1972	2010
320 WEST 76 STREET	ROCKMILLS MP 150		1	6.00	6.00	6.00	1983	2018
320 WEST END AVENUE	ROCKMILLS MP-125		1	5.20	5.20	5.20	1979	2014
321 WEST 78 STREET	FEDERAL FST 150		1	6.27	6.27	11.27	1987	2022
321 WEST 78 STREET	FEDERAL FST-150 (NEW)	DUAL FUEL	1	5.00	5.00		2006	2041
322 WEST 72 STREET	FEDERAL FST 125		1	4.20	4.20	4.20	1983	2018
325 RIVERSIDE DRIVE	ROCKMILLS 4-162		1	6.44	6.44	6.44	1980	2015
325 WEST 86 STREET	FEDERAL FST 125		1	5.32	5.32	5.32	1989	2024
325 WEST END AVENUE	FEDERAL FLW 3643		1	15.50	15.50	23.80	1968	2010
325 WEST END AVENUE	BEST 5D-250 (NEW)	DUAL FUEL	1	8.30	8.30		2006	2041
328 WEST 86 STREET	FEDERAL FST 125		1	5.25	5.25	5.25	1989	2024
33 WEST 67 STREET	ROCKMILLS MP125		1	5.00	5.00	5.00	1985	2020
330 WEST 72 STREET	FEDERAL #FST-200		1	7.00	7.00	7.00	1981	2016
333 CENTRAL PARK WEST	FEDERAL FST 250		1	10.40	10.40	10.40	1987	2022
333 WEST END AVENUE	ROCKMILLS MP-200		1	7.10	7.10	7.10	1971	2010
336 CENTRAL PARK WEST	ROCK MP 300		1	12.60	12.60	25.20	1976	2011
336 CENTRAL PARK WEST	FEDERAL FST-300	DUAL FUEL	1	12.60	12.60		2000	2035
336 WEST END AVENUE	FEDERAL MODEL FST 250		1	10.80	10.80	10.80	1978	2013
340 RIVERSIDE DRIVE	ROCKMILLS MP-175		1	7.35	7.35	7.35	1992	2027
345 RIVERSIDE DRIVE	FEDERAL FST-100		1	4.20	4.20	4.20	1985	2020
35 WEST 81 STREET	FEDERAL FST 100		1	4.20	4.20	4.20	1988	2023
355 RIVERSIDE DRIVE	ROCKMILLS-MP 100		1	3.50	3.50	3.50	1979	2014
360 RIVERSIDE	ROCKMILLS MP100		1	4.10	4.10	4.10	1989	2024

DRIVE								
37 WEST 93 STREET	FEDERAL FST 100		1	3.80	3.80	3.80	1983	2018
370 CENTRAL PARK WEST	ROCKMILLS MP 125 SL		1	5.25	5.25	5.25	1992	2027
370 RIVERSIDE DRIVE	BEST-5C-150 (NEW)	DUAL FUEL	1	5.02	5.02	5.02	2005	2040
375 RIVERSIDE DRIVE	FEDERAL FST-300		1	12.62	12.62	12.62	1978	2013
380 RIVERSIDE DRIVE	FEDERAL FST 300		1	12.60	12.60	12.60	1980	2015
390 RIVERSIDE DRIVE	ROCKMILLS MP-250		1	10.36	10.36	10.36	1982	2017
40 WEST 67 STREET	FEDERAL FST-100	DUAL FUEL	1	4.20	4.20	4.20	2001	2036
40 WEST 77 STREET	ROCKMILLS MP 300		1	11.00	11.00	23.60	1981	2016
40 WEST 77 STREET	ROCKMILLS MP-300	DUAL FUEL	1	12.60	12.60		2001	2036
400 RIVERSIDE DRIVE	ROCKMILLS MP 150		1	6.30	6.30	6.30	1972	2010
401 WEST END AVENUE	FEDERAL FST-125		1	5.30	5.30	5.30	1984	2019
41 WEST 82 STREET	FEDERAL FST-90		1	3.80	3.80	3.80	1985	2020
411 WEST END AVENUE	ROCKMILLS MP-150		2	5.02	10.04	10.04	1985	2020
415 CENTRAL PARK WEST	(EXISTING) ROCKMILLS MP 250	DUAL FUEL	1	0.00	0.00	0.00	2003	2038
44 WEST 77 STREET	ROCKMILLS MP 150		1	6.44	6.44	6.44	1979	2014
440 WEST END AVENUE	FED FST-300		1	11.30	11.30	11.30	1985	2020
444 CENTRAL PARK WEST	FEDERAL FST-300		1	3.80	3.80	12.20	1983	2018
444 CENTRAL PARK WEST	FEDERAL FST 250		1	8.40	8.40		1985	2020
465 WEST END AVENUE	FEDERAL #FST-200		1	7.30	7.30	7.30	1985	2020
470 WEST END AVENUE	FEDERAL FST-250		1	10.40	10.40	10.40	1984	2019
473 WEST END AVENUE	ROCKMILLS MP50		1	5.20	5.20	5.20	1972	2010
49 WEST 72 STREET	BEST 5B-100 (NEW)	DUAL FUEL	1	3.30	3.30	3.30	2005	2040
490 WEST END AVENUE	ROCKMILLS MP-250		1	11.10	11.10	11.10	1993	2028
5 RIVERSIDE DRIVE	FITZGIBBONS RM 212		1	7.40	7.40	17.80	1973	2010
5 RIVERSIDE DRIVE	FEDERAL FST 250	DUAL FUEL	1	10.40	10.40		2001	2036
50 CENTRAL PARK WEST	(EXISTING) ROCKMILLS-MP 250	DUAL FUEL	1	8.37	8.37	8.37	2003	2038
50 RIVERSIDE DRIVE	FEDERAL FST 350		1	15.00	15.00	15.00	1979	2014
50 WEST 67 STREET	FEDERAL FST-150		1	6.27	6.27	6.27	1993	2028
500 WEST 111 STREET	FEDERAL FST-100		1	4.20	4.20	4.20	1985	2020
505 WEST END AVENUE	ROCKMILLS MP-200		1	8.20	8.20	8.20	1986	2021
514 WEST END AVENUE	ROCKMILLS MP-125		1	5.63	5.63	5.63	1992	2027
515 WEST END AVENUE	ROCKMILLS MP 200		1	8.20	8.20	8.20	1983	2018
52 RIVERSIDE DRIVE	ROCKMILLS MP-100		1	4.46	4.46	4.46	1975	2010
522 WEST END AVENUE	FEDERAL FST 150	DUAL FUEL	1	6.40	6.40	6.40	1980	2015
528 WEST 111 STREET	FEDERAL FST-80	DUAL FUEL	1	3.43	3.43	3.43	2000	2035

532 WEST 111 STREET	ROCKMILLS MP-80	DUAL FUEL	1	3.14	3.14	3.14	1996	2031
535 WEST 110 STREET	ROCKMILLSMP-250	DUAL FUEL	1	10.80	10.80	10.80	1980	2015
545 WEST END AVENUE	FEDERAL FST 250		1	8.10	8.10	8.10	1970	2010
55 CENTRAL PARK WEST	ROCKMILLS MP-250		1	10.40	10.40	20.76	1980	2015
55 CENTRAL PARK WEST	FEDERAL FST-250	DUAL FUEL	1	10.36	10.36		1997	2032
562 WEST END AVENUE	(EXISTING)TITUSVILLE (UNKNOWN)	DUAL FUEL	1	6.30	6.30	10.40	1995	2030
562 WEST END AVENUE	BEST 5C - 125 (NEW)	DUAL FUEL	1	4.10	4.10		2006	2041
565 WEST END AVENUE	FITZGIBBONS M242		1	7.10	7.10	15.30	1973	2010
565 WEST END AVENUE	FEDERAL FST-200	DUAL FUEL	1	8.20	8.20		1997	2032
588 WEST END AVENUE	FEDERAL FST-125		1	5.25	5.25	5.25	1990	2025
59 WEST 71 STREET	ROCKMILLS (MP-125)		1	4.20	4.20	4.20	1973	2010
590 WEST END AVENUE	ROCKMILLS MP150		1	6.30	6.30	6.30	1984	2019
6 WEST 77 STREET	EASTMOND ESP 200	DUAL FUEL	1	8.10	8.10	8.10	1999	2034
60 WEST 68 STREET	ROCKMILLS MP-125 (EXTSG)	DUAL FUEL	1	4.18	4.18	4.18	2002	2037
600 WEST END AVENUE	ROCKMILLS MP 200		1	5.74	5.74	5.74	1969	2010
609 WEST 114 STREET	FEDERAL FM 1822		1	6.30	6.30	6.30	1985	2020
610 WEST END AVENUE	ROCKMILLS #MP-200		1	8.20	8.20	8.20	1983	2018
611 WEST 111 STREET	FEDERAL FST-100	DUAL FUEL	1	4.10	4.10	4.10	1996	2031
639 WEST END AVENUE	SPENCER FPC 5733 A	DUAL FUEL	1	6.65	6.65	6.65	2002	2037
645 WEST END AVENUE	ROCKMILLS MP250		1	10.50	10.50	10.50	1973	2010
65 WEST 95 STREET	ROCKMILLS MP - 150 (NEW)	DUAL FUEL	1	5.00	5.00	5.00	2008	2043
670 WEST END AVENUE	ROCKMILLS MP200		1	8.19	8.19	8.19	1990	2025
677 WEST END AVENUE	ROCKMILLS MP-175	DUAL FUEL	1	7.35	7.35	7.35	1995	2030
685 WEST END AVENUE	FEDERAL FST #150		1	6.27	6.27	6.27	1993	2028
7 WEST 96 STREET	ROCKMILLS MP4-212		1	8.10	8.10	8.10	1977	2012
70 RIVERSIDE DRIVE	FEDERAL FST 150	DUAL FUEL	1	6.30	6.30	6.30	2000	2035
710 WEST END AVENUE	FEDERAL FST 175		1	7.28	7.28	7.28	1984	2019
75 CENTRAL PARK WEST	EASTMOND/FEDERAL FST-100	DUAL FUEL	2	4.20	8.40	8.40	1996	2031
755 WEST END AVENUE	FEDERAL FST - 175 (NEW)	DUAL FUEL	1	5.80	5.80	5.80	2006	2041
760 WEST END AVENUE	BEST 5 C 175		1	7.36	7.36	7.36	1987	2022
771 WEST END AVENUE	FEDERAL FST-300		1	11.70	11.70	11.70	1973	2010
789 WEST END AVENUE	ROCKMILLS MP175		1	7.35	7.35	7.35	1977	2012
800 WEST END AVENUE	ROCKMILLS MP4-231		1	10.00	10.00	10.00	1980	2015
801 WEST END AVENUE	EASTMOND ESP-70	DUAL FUEL	2	2.49	4.98	4.98	1996	2031

839 WEST END AVENUE	ROCKMILLS MP125		1	4.95	4.95	4.95	1981	2016
875 WEST END AVENUE	FEDERAL FST 250		1	10.40	10.40	10.40	1987	2022
88 CENTRAL PARK WEST	FEDERAL FMB 2429		2	9.80	19.60	19.60	1966	2010
885 WEST END AVENUE	ROCKMILLS MP- 200	DUAL FUEL	1	8.40	8.40	8.40	2000	2035
890 WEST END AVENUE	FEDERAL FST-200SP		1	7.80	7.80	7.80	1971	2010
895 WEST END AVENUE	ROCKMILLS MP-175		1	7.35	7.35	7.35	1986	2021
90 RIVERSIDE DRIVE	FEDERAL FLW 3643		1	13.20	13.20	27.90	1971	2010
90 RIVERSIDE DRIVE	FEDERAL FST-350	DUAL FUEL	1	14.70	14.70		1995	2030
924 WEST END AVENUE	FEDERAL FST 250		1	9.95	9.95	9.95	1983	2018

Appendix E: Available Financial Incentives & Grants

Refundable Clean Heating Fuel Tax Credit (Corporate)

The state of New York began offering a corporate income tax credit for biodiesel purchases used for residential space heating and water heating beginning in 2006. The original credit was authorized for only one year from July 1, 2006 to June 30, 2007. However, in 2008 the law was amended to reinstate the credit for purchases made between January 1, 2008 and December 31, 2011. The window was extended through December 31, 2016 by A.B. 7793 in October 2011. Eligible taxpayers are defined as corporations that are subject to the franchise tax on business corporations, including a corporation that is a partner in a partnership.

The value of the tax credit is $0.01/gallon for each percent of biodiesel blended with conventional home heating oil, up to a maximum of $0.20/ gallon. In other words, the purchaser of a mixture of 10% biodiesel and 90% conventional heating oil is entitled to a tax credit of $0.10/gallon. Biodiesel is defined to include certain fuels created from both animal fats and vegetable oils. Biodiesel use in buildings with both residential and non-residential space and a common oil storage tank is eligible for a partial credit based on the percentage of square footage used for residential purposes. If a taxpayer's allowable credit exceeds their tax liability for a given year, the remaining credit is refunded rather than carried over to a subsequent tax year.

In order to claim the tax credit corporate income taxpayers must complete Form CT-241, which is available on the New York State Department of Taxation and Finance web site.

Refundable Clean Heating Fuel Tax Credit (Personal)

The state of New York began offering a personal income tax credit for biodiesel purchases used for residential space heating and water heating beginning in 2006. The original credit was authorized for only one year from July 1, 2006 to June 30, 2007. However, in 2008 the law was amended to reinstate the credit for purchases made between January 1, 2008 and December 31, 2011. Eligible taxpayers are defined as individuals; members of a partnership or an LLC treated as a partnership for tax purposes; shareholders in New York S Corporations; and beneficiaries of an estate or trust.

The value of the tax credit is $0.01/gallon for each percent of biodiesel blended with conventional home heating oil, up to a maximum of $0.20/ gallon. In other words, the purchaser of a mixture of 10% biodiesel and 90% conventional heating oil is entitled to a tax credit of $0.10/gallon. Biodiesel is defined to include certain fuels created from both animal fats and vegetable oils. Biodiesel use in buildings with both residential and non-residential space and a common oil storage tank is eligible for a partial credit based on the percentage of square footage used for residential purposes. If a taxpayer's allowable credit exceeds their tax liability for a given year, the remaining credit is refunded rather than carried over to a subsequent tax year.

In order to claim the tax credit personal income taxpayers must complete Form IT-241, which is available on the New York State Department of Taxation and Finance web site.

Residential Solar Tax Credit

Enacted in August 1997, this personal income tax credit originally applied to expenditures on solar-electric (PV) equipment used on residential property. The credit, equal to 25% percent of the cost of equipment and installation, was expanded in August 2005 to include solar-thermal equipment. The solar-thermal provisions apply to taxable years beginning on and after January 1, 2006. The credit is capped at $3,750 for solar-energy systems placed in service before September 1, 2006, and capped at $5,000 for solar-energy systems placed in service on or after September 1, 2006.

Solar-energy equipment is defined as "an arrangement or combination of components utilizing solar radiation, which, when installed in a residence, produces energy designed to provide heating, cooling, hot water or electricity." The credit may not be used for pool heating or other recreational applications. Any amount of credit that exceeds a taxpayer's liability in a given tax year may be carried forward for the five following taxable years. Any portion of the system cost provided by a non-taxable federal, state, or local grant is not eligible for this credit.

Systems must comply with the 25 kW capacity limit on residential, net-metered solar-energy systems*. In 2007, legislation was passed increasing the capacity limit to 50 kW for condominiums and cooperative housing associations. In addition, members of condominium management associations and tenant stockholders of cooperative housing associations are now allowed to claim a proportionate share of the total system expense towards the tax credit. These changes took effect beginning in the 2007 tax year, but as with other portions of the tax credit, they do not have an expiration date.

Energy Conservation Improvements Property Tax Exemption

Qualifying energy-conservation improvements to homes are exempt from real property taxation to the extent that the addition would increase the value of the home. The exemption includes general municipal property taxes, school district taxes, and special ad valorem taxes, but does *not apply* to special assessments. Eligible properties include single-family to four-family dwellings. The exemption applies directly to a variety of equipment and measures, but the statute also states that any conservation-related state or federal tax credit or deduction is also exempt from New York's property tax under this statute. The federal energy efficiency tax credit can be applied to energy efficient central air conditioners, electric heat pump water heaters, natural gas, propane, or oil water heaters, advanced main air circulating fans, and certain biomass-fueled stoves. In addition, the state Tax Assessor's Manual also specifically identifies solar and wind energy systems as eligible for the exemption.

New York City - Property Tax Abatement for Photovoltaic (PV) Equipment Expenditures

In August 2008 the State of New York enacted legislation allowing a property tax abatement for photovoltaic (PV) system expenditures made on buildings located in cities with a population of 1 million or more people. This limits the abatement to systems installed within New York City. Eligible buildings include all real property except utility real property.

The abatement allows building owners to deduct from their total real property taxes* a portion of the expenditures associated with installing a PV system on an eligible building. Systems placed in service between August 5, 2008 (the effective date) and December 31, 2010 were eligible for an abatement of 8.75% of eligible

expenditures annually for four years. Systems placed in service between January 1, 2011 and December 31, 2012 are eligible for an abatement of 5.0% of eligible expenditures annually for 4 years. Thus the total property tax benefit can amount to either 35% or 20% of the installed system cost depending on when it is built.

The maximum abatement during a year is $62,500 or the amount of real property taxes owed during the year. Unused balances *may not* be carried forward to subsequent years. Eligible expenditures include reasonable expenditures for materials and labor associated with planning, designing, and installing the system. Expenditures incurred using a federal, state, or local grant are not eligible, nor are interest or finance charges. However, the amount of eligible expenditures is not reduced by federal, state or local tax credits, tax abatements, tax exemptions or tax rebates.

ConEd (Gas) - Residential Energy Efficiency Incentives Program

Con Edison is offering the Residential HVAC Gas Rebate Program. Through this program, incentives are offered on energy efficient heating and cooling equipment for residences in the eligible service area. Service addresses that have one to four residential dwelling units may participate in the program. Eligible measures and equipment include furnaces, water boilers, steam boilers, boiler controls, indirect water heaters, duct/air sealing, and programmable thermostats. All equipment must be installed by a participating contractor and installations may be inspected before incentive payments.

ConEd (Electric) - Residential Energy Efficiency Incentives Program

Con Edison is offering the Residential HVAC Electric Rebate Program. Through this program, incentives are offered on energy efficient heating and cooling equipment for residences in the eligible service area. Service addresses that have one to four residential dwelling units may participate in the program. Eligible measures and equipment include central air conditioning units, heat pumps, water heaters, furnace fans, weatherization measures, and thermostats. All equipment must be installed by a participating contractor and installations may be inspected before incentive payments.

The Central Air Conditioning Program is offered to residential customers who wish to more effectively manage energy costs. The program provides a free programmable thermostat, capable of managing energy use over the internet or manually. The thermostat will be connected to the customer's central air conditioning system. See web site above for more details on both programs.

The Targeted Demand Side Management program pays contractors to conduct energy surveys and install free CFLs in areas where demand is determined to be high. Multifamily buildings 5-75 units are eligible for free surveys and installation of efficient electric and gas devices, including rebates for lighting, heating, cooling, ENERGY STAR refrigerators, air conditioners, boilers, furnaces, and hot water heaters.

Appendix F: Description of Five Additional Initiatives in the Energy Section of PlaNYC

Initiative 3: Improve codes and regulations to increase the sustainability of buildings

At the core of this initiative is the creation of the New York City Green Codes Task Force (GCTF), a product of the Urban Green Council and the Mayor's Office. The GCTF generated 111 specific proposals for sustainable improvements to existing building codes in New York City, in addition to continued support for the city-wide adoption of the most progressive green building codes released by The International Code Council.

Initiative 4: Improve compliance with the energy code and track green building improvements citywide

PlaNYC seeks to build a comprehensive database of "Green Building Report Cards" to help future designers, building engineers, building managers, and residents see how buildings are meeting green codes, and how to undertake certain projects such as the conversion of dirty fuels to cleaner fuels.

Initiative 6: Improve energy efficiency in historic buildings

A major obstacle toward whole building retrofits in New York City is the historical preservation laws and regulations that prevent exterior revision and comprehensive building insulation. Having recognized this challenge, PlaNYC is determined to work with historic preservation societies to create special handbooks that deal solely with efficiency strategies in historic buildings.

Initiative 7: Provide energy efficiency financing and information

At the heart of this initiative is the establishment of the New York City Energy Efficiency Corporation (NYCEEC), a non-profit funded via federal stimulus monies, commercial lenders, and philanthropic sources. The goal is to complement all New York State funding for energy efficiency measures as well as become a center for all important information regarding tax incentives, funding program, and efficiency initiatives.

Initiative 15: Increase natural gas transmission and distribution capacity to improve reliability and encourage conversion from highly polluting fuels

With increasing energy demand, the Mayor's Office has identified natural gas as the future for New York City. Low prices, an existing but underperforming infrastructure, and a strong alternative to dirty oil fuels, PlaNYC is determined to build out natural gas infrastructure, primarily through direct work with utilities and collaboration with building managers to create 'clusters of buildings' that will create economies of scale. This is of particular importance for our Master's Project as conversion from No. 6 and No. 4 oil to natural gas is a major focus of analysis.

END NOTES

[i] M.J. Bradley & Associates LLC and Urban Green Council, "Bottom of the Barrel – How the Dirtiest Heating Oil Pollutes Our Air and Harms Our Health". Written for Environmental Defense Fund. December 16, 2009. Pg. 4. (future references will be noted as follows: 'EDF, "Bottom of the Barrel", pg. #)

[ii] 546 No. 6 oil burning Upper West Side buildings / 4888 total NYC No. 6 oil burning buildings (Oil Boilers – Detailed Fuel Consumption and Building Data. NYC Open Data. 'Assumptions' tab. Obtained online.)

[iii] Land mass/population – 1. City-Data, "UWS Detailed Profile". Urban Mapping Inc.. 2011. http://www.city-data.com , 2. Census Bureau, "Census 2010 – New York City". 2011. http://2010.census.gov/news/releases/operations/cb11-cn122.html

[iv] US DOE, 2008 Buildings Energy Data Book, http://buildingsdatabook.eren.doe.gov/

[v] City of New York, Inventory of New York City Greenhouse Gas Emissions, September 2011, by Jonathan Dickinson and Andrea Tenorio. Mayor's Office of Long-Term Planning and Sustainability, New York, 2011. Web. February 2012. http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/greenhousegas_2011.pdf

[vi] Ibid.

[vii] EPA, Heat Island Effect http://www.epa.gov/heatisld/index.htm

[viii] EPA, Heat Island Impacts, http://www.epa.gov/heatisld/impacts/index.htm

[ix] NYC.gov, "Department of Environmental Protection and Department of Buildings Unveil New Program to Streamline Approval Process for Upgrading Boilers". The City of New York. May 23, 2011. http://www.nyc.gov/html/dep/html/press_releases/11-39pr.shtml

[x] 30.7% of existing boilers in our area of study have this immediate capability

[xi] Ibid.

[xii] "The New Efficient Light Bulbs." Natural Resources Defense Council. 3 July 2011. Web. 24 Feb. 2012. http://www.nrdc.org/energy/lightbulbs/ .

[xiii] Hirschfeld, Herbert E., et al., "*Residential Electrical Sub-metering Manual*", New York State Energy Research Development Authority, 2001. Page 5. http://www.submeteronline.com/pdf/subman2001.pdf

[xiv] Wikipedia, "Building Envelope", http://en.wikipedia.org/wiki/Building_envelope

[xv] Greg Pedrick, "Emerging Insulation Practice for Residential: Deep Energy Retrofit", New York State Energy Research Development Authority, http://www.aging.ny.gov/LivableNY/ResourceManual/Design/IV2e.pdf

[xvi] Federal Energy Regulatory Commission. "New Jersey - New York Expansion Project: Final Environmental Impact Statement, Volume I". pg. 2-1.

[xvii] New York Times, "EPA Links Tainted Water in Wyoming to Hydraulic Fracturing for Natural Gas", December 8, 2011. http://www.nytimes.com/2011/12/09/us/epa-says-hydraulic-fracturing-likely-marred-wyoming-water.html

[xviii] Bloomberg. "Tighter Fracking Regulations Favored by 65% of US in Poll", March 15, 2012. http://www.bloomberg.com/news/2012-03-15/tighter-fracking-regulations-favored-by-65-of-u-s-in-poll.html

[xix] EDF, "Bottom of the Barrel", pg. 4.

[xx] U.S. Department of Energy – Energy Efficiency and Renewable Energy, "1.1.3 Buildings Share of U.S. Primary Energy Consumption (Percent)". Buildings Energy Data Book. U.S. Department of Energy. March 2011.

[xxi] EDF, "Bottom of the Barrel", pg 29.

[xxii] EDF, "Bottom of the Barrel", pg 29.

[xxiii] EDF, "Bottom of the Barrel", pg 30.

[xxiv] EDF, "Bottom of the Barrel", pg 31.

[xxv] EDF, "Bottom of the Barrel", pg 31.

[xxvi] See case studies at www.edf.org/cleanheat.

[xxvii] EDF, "Bottom of the Barrel", pg 33.

[xxviii] EDF, "Bottom of the Barrel". Pg. 16.

[xxix] EDF, "Bottom of the Barrel". Pg 18.

[xxx] EPA, Heat Island Effect http://www.epa.gov/heatisld/index.htm

[xxxi] EPA, Heat Island Impacts, http://www.epa.gov/heatisld/impacts/index.htm

[xxxii] EPA, Heat Island Impacts, http://www.epa.gov/heatisld/impacts/index.htm

[xxxiii] EPA, Heat Island Impacts, http://www.epa.gov/heatisld/impacts/index.htm

[xxxiv] EPA, Heat Island Impacts, http://www.epa.gov/heatisld/impacts/index.htm

[xxxv] Federal Technology Alert, Green Roofs, http://www.nrel.gov/docs/fy04osti/36060.pdf

[xxxvi] US Census (2000) "American Fact Finder: Units in Structure:2000" Retrieved Feb 22, 2012, from Retrieved Feb 22, 2012, http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_00_SF3_H030&prodType=table

[xxxvii] US Census (2010) "American Fact Finder: ZCTA5 10023, 10024, 10025 General Housing Characteristics: 2010" Retrieved Feb 22, 2012, from http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_SF1_QTH1&prodType=table

[xxxviii] US Census Bureau. "Profile of Selected Economic Characteristics: 2000" US Census Bureau. http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_00_SF3_H030&prodType=table, 2001.

[xxxix] Trulia, "Upper West Side Market Trends", Truila, http://www.trulia.com/real_estate/Upper_West_Side-New_York/5261/market-trends/, 2012.

[xl] StreetEasy, "StreetEasy: Area Information About the Upper West in NYC", StreetEasy, http://streeteasy.com/nyc/area/upper-west-side-manhattan, 2012.

[xli] Manhattan Apartments, http://www.manhattanapts.com/buildings.html

[xlii] Manhattan Apartments,http://www.manhattanapts.com/buildings.html

[xliii] Chicago Tribune, Cityscapes, http://featuresblogs.chicagotribune.com/theskyline/2011/02/when-it-comes-toofficialy-eco-friendly-buildingschicago-easily-outpaces-its-competitors-around-the-united-states-according.html

[xliv]Battery Park condos 'LEED' the way, http://therealdeal.com/newyork/articles/battery-park-city-condos-has-high-proportion-of-leed-certified-buildings

[xlv] USGBC, 50 U.S. STATES RANKED BY TOTAL NUMBER OF LEED PROJECTS, http://www.usgbc.org/ShowFile.aspx?DocumentID=7744

[xlvi] City of New York, Inventory of New York City Greenhouse Gas Emissions, September 2011, by Jonathan Dickinson and Andrea Tenorio. Mayor's Office of Long-Term Planning and Sustainability, New York, 2011. Web. February 2012. http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/greenhousegas_2011.pdf

[xlvii] "Greener, Greater Buildings Plan." *PlaNYC*. City of New York. Web. 24 Feb. 2012. http://www.nyc.gov/html/planyc2030/html/about/ggbp.html

[xlviii] City of New York, Inventory of New York City Greenhouse Gas Emissions, September 2011, by Jonathan Dickinson and Andrea Tenorio. Mayor's Office of Long-Term Planning and Sustainability, New York, 2011. Web. February 2012. http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/greenhousegas_2011.pdf

[xlix] Ibid.

[l] PLANYC, Inventory of NYC Greenhouse Gas Emissions, September 2011 http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/greenhousegas_2011.pdf

[li] PLANYC, Inventory of NYC Greenhouse Gas Emissions, September 2011 http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/greenhousegas_2011.pdf

[lii] Michael A. Weber, Energy Efficiency: The Low Hanging Fruit, Page 1, http://files.earthday.net/backgroundpdf/Energy%20Efficiency%20Background.pdf

[liii] Michael A. Weber, Energy Efficiency: The Low Hanging Fruit, Page 1, http://files.earthday.net/backgroundpdf/Energy%20Efficiency%20Background.pdf

[liv] Environmental Defense Fund, Climate Corps Handbook, Page 2, http://edfclimatecorps.org/

[lv] Energy Information Administration, "Commercial Buildings Energy Consumption Survey (CBECS): Table C2A. Total Energy Expenditures by Major Fuel for All Buildings, 2003." September 2008. http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html

[lvi] Flex Your Power, "Commercial Sector.", http://www.fypower.org/com

[lvii] Flex Your Power, "Best Practice Guide: Commercial Office Buildings." http://www.fypower.org/com/bpg

[lviii] Miller, N., Spivey, J., and Florance, A. "Does Green Pay off?" July 2008, http://www.usgbc.org/ShowFile.aspx?DocumentID=5537

[lix] NYC.gov, "PlaNYC – Who We Are". The City of New York. 2012. http://home2.nyc.gov/html/planyc2030/html/about/about.shtml

[lx] NYC.gov, "PlaNYC – The Plan". The City of New York. 2012. http://home2.nyc.gov/html/planyc2030/html/theplan/the-plan.shtml

[lxi] NYC.gov, "PlaNYC – Greener, Greater Buildings Plan". The City of New York. 2012. http://www.nyc.gov/html/planyc2030/html/about/ggbp.shtml

[lxii] NYC Buildings, "Energy Code Guidelines". The City of New York. 2012. http://www.nyc.gov/html/dob/html/codes_and_reference_materials/nycecc_main.shtml

[lxiii] NYC.gov, "Local Laws of the City of New York – For the Year 2009 – No. 84", The City of New York. 2009. http://www.nyc.gov/html/planyc2030/downloads/pdf/ll84of2009_benchmarking.pdf

[lxiv] NYC.gov, "Local Laws of the City of New York – For the Year 2009 – No. 87", The City of New York. 2009. http://www.nyc.gov/html/planyc2030/downloads/pdf/ll87of2009_audits_and_retro-commissioning.pdf

[lxv] NYC.gov, "Local Laws of the City of New York – For the Year 2009 – No. 88", The City of New York. 2009 http://www.nyc.gov/html/planyc2030/downloads/pdf/ll88of2009_lighting_upgrades_and_sub-meters.pdf

[lxvi] Ibid.

[lxvii] Ibid.

[lxviii] The City of New York, "PlaNYC – A Greener, Greater New York". Update April 2011. Pg. 129.

[lxix] NYC.gov, "Department of Environmental Protection and Department of Buildings Unveil New Program to Streamline Approval Process for Upgrading Boilers". The City of New York. May 23, 2011. http://www.nyc.gov/html/dep/html/press_releases/11-39pr.shtml

[lxx] NYC Department of Housing Preservation & Development. "The ABCs of Housing", New York City Department of Housing Preservation and Development, http://www.housingnyc.com/html/resources/attygenguide.html, April 2011. pg. 12.

[lxxi] New York City Rent Guidelines Board. "Rent Stabilization FAQ", NYC RGB. http://www.housingnyc.com/html/resources/faq/rentstab.html, June 26, 2011.

[lxxii] Kennedy, Shawn G., "Q and A" New York Times, May 21, 1986.

[lxxiii] Condominium Act. Article 9B. Section 339-N. Real Property Law. http://public.leginfo.state.ny.us/LAWSSEAF.cgi?QUERYTYPE=LAWS+&QUERYDATA=$$RPP339-N$$@TXRPP0339-N+&LIST=LAW+&BROWSER=BROWSER+&TOKEN=09737587+&TARGET=VIEW, n. d.

[lxxiv] Ibid.

[lxxv] Condominium Act. Article 9B. Section 339-M. Real Property Law. http://public.leginfo.state.ny.us/LAWSSEAF.cgi?QUERYTYPE=LAWS+&QUERYDATA=$$RPP339-M$$@TXRPP0339-M+&LIST=LAW+&BROWSER=BROWSER+&TOKEN=09737587+&TARGET=VIEW, n. d.

[lxxvi] Deller, Steven; Hoyt, Ann; Hueth, Brent and Sundaram-Stukel, Reka, "Research on the Economic Impact of Cooperatives", University of Wisconsin, http://reic.uwcc.wisc.edu/house/, June 2009. pg. 30.

[lxxvii] National Association of Housing Cooperatives. "What is a Housing Cooperative", NAHC, http://www.coophousing.org/DisplayPage.aspx?id=48, n. d.

[lxxviii] Ibid.

[lxxix] Landmark West!, "Maps and Building Data", Landmark West!, http://www.landmarkwest.org/maps_and_data.html, n. d.

[lxxx] Landmark West!, "Upper West Side Building Database", Landmark West!, http://www.landmarkwest.org/landmark_search.php, 2009.

[lxxxi] EIA, "AEO2012 Early Release Overview". Data Table A3: Energy Prices By Sector and Source. January 23, 2012. http://www.eia.gov/forecasts/aeo/er/

[lxxxii] EDF, "Bottom of the Barrel", pg. 42.

[lxxxiii] Ibid, pg. 62

[lxxxiv] Oil Boilers – Detailed Fuel Consumption and Building Data. NYC Open Data. 'Assumptions' tab. Obtained online. http://nycopendata.socrata.com/Facilities-and-Structures/Oil-Boilers-Detailed-Fuel-Consumption-and-Building/jfzu-yy6n

[lxxxv] EDF, "Bottom of the Barrel", pg. 70.

[lxxxvi] EDF, "Bottom of the Barrel", pg. 69.

[lxxxvii] EDF, "Bottom of the Barrel", pg. 69.

[lxxxviii] Oil Boilers – Detailed Fuel Consumption and Building Data. NYC Open Data. 'Assumptions' tab. Obtained online. http://nycopendata.socrata.com/Facilities-and-Structures/Oil-Boilers-Detailed-Fuel-Consumption-and-Building/jfzu-yy6n

[lxxxix] Oil Boilers – Detailed Fuel Consumption and Building Data. NYC Open Data. 'Assumptions' tab. Obtained online. http://nycopendata.socrata.com/Facilities-and-Structures/Oil-Boilers-Detailed-Fuel-Consumption-and-Building/jfzu-yy6n

[xc] Oil Boilers – Detailed Fuel Consumption and Building Data. NYC Open Data. 'Assumptions' tab. Obtained online. http://nycopendata.socrata.com/Facilities-and-Structures/Oil-Boilers-Detailed-Fuel-Consumption-and-Building/jfzu-yy6n

[xci] Numbers generated using combustion emissions values from "Bottom of the Barrel", pg. 36.

[xcii] Divide 0.13 into Particulate Matter savings. EPA Office of Transportation and Air Quality, "Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks", United States Environmental Protection Agency. https://www.whatcomsmarttrips.org/pdf/Emission Facts 2005.pdf

[xciii] Ibid, divide 25.1 into NOx savings

[xciv] Ibid, divide 9,760 into CO2 savings

[xcv] EPA Clean Energy, "eGrid 2010". United States Environmental Protection Agency. October 24, 2011. http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html

[xcvi] EIA, "Frequently Asked Questions". December 6, 2011. http://205.254.135.24/tools/faqs/faq.cfm?id=97&t=3

[xcvii] EDF, "Bottom of the Barrel", pg. 43.

[xcviii] EDF, "Bottom of the Barrel", pg. 69.

[xcix] Oil Boilers – Detailed Fuel Consumption and Building Data. NYC Open Data. 'Assumptions' tab. Obtained online. http://nycopendata.socrata.com/Facilities-and-Structures/Oil-Boilers-Detailed-Fuel-Consumption-and-Building/jfzu-yy6n

[c] EDF, "Bottom of the Barrel", pg. 69.

[ci] EDF, "Bottom of the Barrel", pg. 69.

[cii] Numbers generated using combustion emissions values from "Bottom of the Barrel", pg. 36.

[ciii] https://www.whatcomsmarttrips.org/pdf/Emission Facts 2005.pdf , divide 0.13 into PM savings

[civ] https://www.whatcomsmarttrips.org/pdf/Emission Facts 2005.pdf , divide 25.1 into NOx savings

[cv] https://www.whatcomsmarttrips.org/pdf/Emission Facts 2005.pdf , divide 9,760 into CO2 savings

[cvi] eGrid 2010 (http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html), http://205.254.135.24/tools/faqs/faq.cfm?id=97&t=3

[cvii] See endnote XLVIII

[cviii] Numbers generated using combustion emissions values from "Bottom of the Barrel", pg. 36.

[cix] See endnote LXXXIV

[cx] See endnote LXXXV

[cxi] See endnote LXXXVI

[cxii] See endnote LIV

[cxiii] Environmental Defense Fund, "Clean Heat NYC case studies", http://www.edf.org/health/clean-heat-nyc-case-studies

[cxiv] Cooper Square Reality, "Fuel Conversion Case Study: Jackson Heights Condominium", EDF.org, http://www.edf.org/sites/default/files/11783_CleanHeatNYC-CaseStudy-JacksonHeightsCondominium.pdf

[cxv] EDF, "Fuel Conversion Case Study: Forest Hills Condominium", EDF.org, http://www.edf.org/sites/default/files/11784_CleanHeatNYC-CaseStudy-ForestHillsCondominium.pdf

[cxvi]Clark Energy, "Cogeneration, Combined Heat and Power", http://www.clarke-energy.com/chp-cogeneration

[cxvii] NYC.org, "Installing Natural Gas-fueled Combined Heat and Power (CHP) Systems", NYC Department of Buildings, 2010, Page 4. http://www.nyc.gov/html/dob/downloads/pdf/combined_heat_and_power_systems.pdf

[cxviii] NYC.org, "Installing Natural Gas-fueled Combined Heat and Power (CHP) Systems", NYC Department of Buildings 2010, Page 4. http://www.nyc.gov/html/dob/downloads/pdf/combined_heat_and_power_systems.pdf

[cxix]http://cdhnrgy1.user.openhosting.com/Documentation/CHP%20Thumbnails/CHP%20Thumbnail--205%20West%20End%20Condo.pdf

[cxx] Con Edison, "Incentive Programs" www.coned.com/dg/incentive_programs/incentivePrograms.as

[cxxi] Database of State Incentives for Renewables and Efficiency, "Business Energy Investment Tax Credit" http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US02F

[cxxii] Calculation was made using data from EPA's eGrid 2010 database and the "Oil Boilers – Detailed Fuel Consumption and Building Data" database.

[cxxiii] Federal Energy Regulatory Commission. "New Jersey - New York Expansion Project: Final Environmental Impact Statement, Volume I". pg. 2-1.

[cxxiv] Spectra Energy. "New Projects: New jersey-New York Expansion". March 23, 2012. http://www.spectraenergy.com/Operations/New-Projects/New-Jersey-New-York-Pipeline/

[cxxv] New York State Energy Planning Board. "Natural Gas Assessment: New York State Energy Plan 2009". Pg. 8. http://www.nysenergyplan.com/final/Natural_Gas_Assessment.pdf

[cxxvi]Energy Information Administration. "AEO2012 Early Release Overview", pg. 1. March 19, 2012. http://www.eia.gov/forecasts/aeo/er/pdf/

[cxxvii] New York Times, "EPA Links Tainted Water in Wyoming to Hydraulic Fracturing for Natural Gas", December 8, 2011. http://www.nytimes.com/2011/12/09/us/epa-says-hydraulic-fracturing-likely-marred-wyoming-water.html

[cxxviii] Bloomberg. "Tighter Fracking Regulations Favored by 65% of US in Poll", March 15, 2012. http://www.bloomberg.com/news/2012-03-15/tighter-fracking-regulations-favored-by-65-of-u-s-in-poll.html

[cxxix] My Upper West Side. "UWS Anti-hydrofracking Rally Tomorrow", February 24, 2012. http://myupperwest.com/upper-west-side/uws-anti-hydrofracking-rally-tomrorow-saturday/

[cxxx]Minimum Temperature to be Maintained, Chapter 2, Article 8, Section 27-2029, Housing Maintenance Code. http://www.housingnyc.com/html/resources/hmc/sub2/art8.html

[cxxxi] EDF, "Bottom of Barrel", pg. 51.

[cxxxii] EDF, "Bottom of Barrel", pg. 52.

[cxxxiii] EDF, "Bottom of Barrel", pg. 51.

[cxxxiv] EDF, "Bottom of Barrel", pg. 52.

[cxxxv] EDF, "Bottom of Barrel", pg. 58.

[cxxxvi] EDF, "Bottom of Barrel", pg. 52.

[cxxxvii] EDF, "Bottom of Barrel", pg. 53.

[cxxxviii] EDF, "Bottom of Barrel", pg. 53.

[cxxxix] EDF, "Bottom of Barrel", pg. 54.

[cxl] EDF, "Bottom of Barrel", pg. 54.

[cxli] EDF, "Bottom of Barrel", pg. 56.

[cxlii] EDF, "Bottom of Barrel", pg. 57.

[cxliii] EDF, "Bottom of Barrel", pg. 58.

[cxliv] "The New Efficient Light Bulbs." Natural Resources Defense Council. 3 July 2011. Web. 24 Feb. 2012. http://www.nrdc.org/energy/lightbulbs/

[cxlv] EDF, "Bottom of Barrel", 65.

[cxlvi] EDF, "Bottom of Barrel", 65.

[cxlvii] U.S. Environmental Protection Agency. Office of Air and Radiation. Energy Star Building Upgrade Manual. U.S. EPA, 2008. Web. 24 Feb. 2012. http://www.energystar.gov/ia/business/EPA_BUM_Full.pdf?bbe9-ec35

[cxlviii] ENERGY STAR Qualified Products. Energy Star. Web. 24 Feb. 2012. http://www.energystar.gov/index.cfm?fuseaction=find_a_product

[cxlix] Ibid.

[cl] The Cooperator , "Submetering Your Building's Electricity", http://cooperator.com/articles/2302/1/Submetering-Your-Building039s-Electricity/Page1.html

[cli] Hirschfeld, Herbert E., et al. "*Residential Electrical Sub-metering Manual"*, New York State Energy Research Development Authority, 2001. http://www.submeteronline.com/pdf/subman2001.pdf

[cliii] Ibid.

[cliii] Ibid.

[cliv] American Conservation and Billing Solutions, "Utility Billing & Sub-metering Services for Affordable Housing." http://www.amcobi.com/billing-a-submetering-services-for-housing-authorities-a-affordable-housing-providers.html

[clv] NYSERDA, ERMMB Program Description, http://www.nyserda.ny.gov/en/Page-Sections/Multifamily-Performance-Program/Existing-Buildings/~/media/Files/EERP/Multifamily%20Homes/Existing%20Buildings/ermm-app-overview.ashx

[clvi] Ibid.

[clvii] Ibid.

[clviii] Submeteronline, "Factors which impact sub-metering implementation cost". http://www.submeteronline.com/code/cost_f.html

[clix] Hirschfeld, Herbert E., et al., "*Residential Electrical Sub-metering Manual"*, New York State Energy Research Development Authority, 2001. Page 13. http://www.submeteronline.com/pdf/subman2001.pdf

[clx] 205westend, "CASE 02-E-0727-Petition of the 205 West End Owners Corporation to Submitter Electricity at 205 West End Avenue", 2002. http://www.205westend.com/home

[clxi] Submeteronline, Case Study: Electrical Submetering at Jefferson Towers Prior to A/C Fleet Control, http://www.submeteronline.com/pdf/JeffersonTowersCaseStudy.pdf

[clxii] PULP(Public Utility Law Project of New York) Network, "PSC and NYSERDA Spend Millions for Sub-metering Projects Violating Residential Tenants' Rights", 2009. http://pulpnetwork.blogspot.com/2009/01/psc-authorizes-millions-for-submetering.html

[clxiii] Pratt Center for Community Development, "Multifamily energy efficiency programs in NYC: an overview, update and look forward", 2011. http://prattcenter.net/sites/default/files/users/pdf/workshops/mcolgrove-nyserda-22june-2011.pdf

[clxiv] Online Code Environment and Advocacy Network, "New York State Energy Code Status" http://bcap-ocean.org/tenplaces/NewYorkCity

[clxv] Wikipedia, "Building Envelope", http://en.wikipedia.org/wiki/Building_envelope

[clxvi] Greg Pedrick, "Emerging Insulation Practice for Residential: Deep Energy Retrofit", New York State Energy Research Development Authority, http://www.aging.ny.gov/LivableNY/ResourceManual/Design/IV2e.pdf

[clxvii] EDF, "Bottom of Barrel", pg. 59.

[clxviii] EDF, "Bottom of Barrel", pg. 59.

[clxix] American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (www.ashrae.org), Evaluating Green Roof Energy Performance, http://www.fsec.ucf.edu/en/media/newsletters/brpost/winter2006/ASHRAEJeffSonne.pdf

[clxx] American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (www.ashrae.org), Evaluating Green Roof Energy Performance, http://www.fsec.ucf.edu/en/media/newsletters/brpost/winter2006/ASHRAEJeffSonne.pdf

[clxxi] Alert, Green Roofs, http://www.nrel.gov/docs/fy04osti/36060.pdf

[clxxii] EPA, Green Roofs, http://www.epa.gov/heatisld/mitigation/greenroofs.htm

[clxxiii] Federal Technology Alert, Green Roofs, http://www.nrel.gov/docs/fy04osti/36060.pdf

[clxxiv] EPA, Green Roofs, http://www.epa.gov/heatisld/mitigation/greenroofs.htm

[clxxv] Federal Technology Alert, Green Roofs, http://www.nrel.gov/docs/fy04osti/36060.pdf

[clxxvi] Corrie Clark, Peter Adriaens, F. Brian Talbot, University of Michigan, Green Roof Valuation: A Probabilistic Economic Analysis of Environmental Benefits, http://www.erb.umich.edu/News-and-Events/colloquium_papers/Clarketal.pdf

[clxxvii] Peck, Steven. 2003. "Towards an Integrated Green Roof Infrastructure Evaluation for Toronto," The Green Roof Infrastructure Monitor, http://www.greenroofs.org/pdf/GRIM-Spring2003.pdf

[clxxviii] Corrie Clark, Peter Adriaens, F. Brian Talbot, University of Michigan, Green Roof Valuation: A Probabilistic Economic Analysis of Environmental Benefits, http://www.erb.umich.edu/News-and-Events/colloquium_papers/Clarketal.pdf

[clxxix] EPA, Green Roofs, http://www.epa.gov/heatisld/mitigation/greenroofs.htm

[clxxx] EPA, Cool Roofs, http://www.epa.gov/heatisld/mitigation/coolroofs.htm

[clxxxi] Mark Z. Jacobson, John E. Ten Hoeve, Effects of Urban Surfaces and White Roofs on Global and Regional Climate, http://www.stanford.edu/group/efmh/jacobson/Articles/Others/HeatIsland+WhiteRfs0911.pdf

[clxxxii] Federal Energy Regulatory Commission, "Demand Response & Advanced Metering Staff Report", FERC. http://www.ferc.gov/legal/staff-reports/demand-response.pdf, 2008. pg. 5.

[clxxxiii] Federal Energy Regulatory Commission, "Demand Response & Advanced Metering Staff Report", FERC. http://www.ferc.gov/legal/staff-reports/demand-response.pdf, 2008. pg. 12.

[clxxxiv] Ibid.

[clxxxv] Con Edison, "Demand Response Providers or Aggregators ", Con Edison. http://www.coned.com/energyefficiency/PDF/Demand%20Response%20Providers%20or%20Aggregators.pdf, n.d.