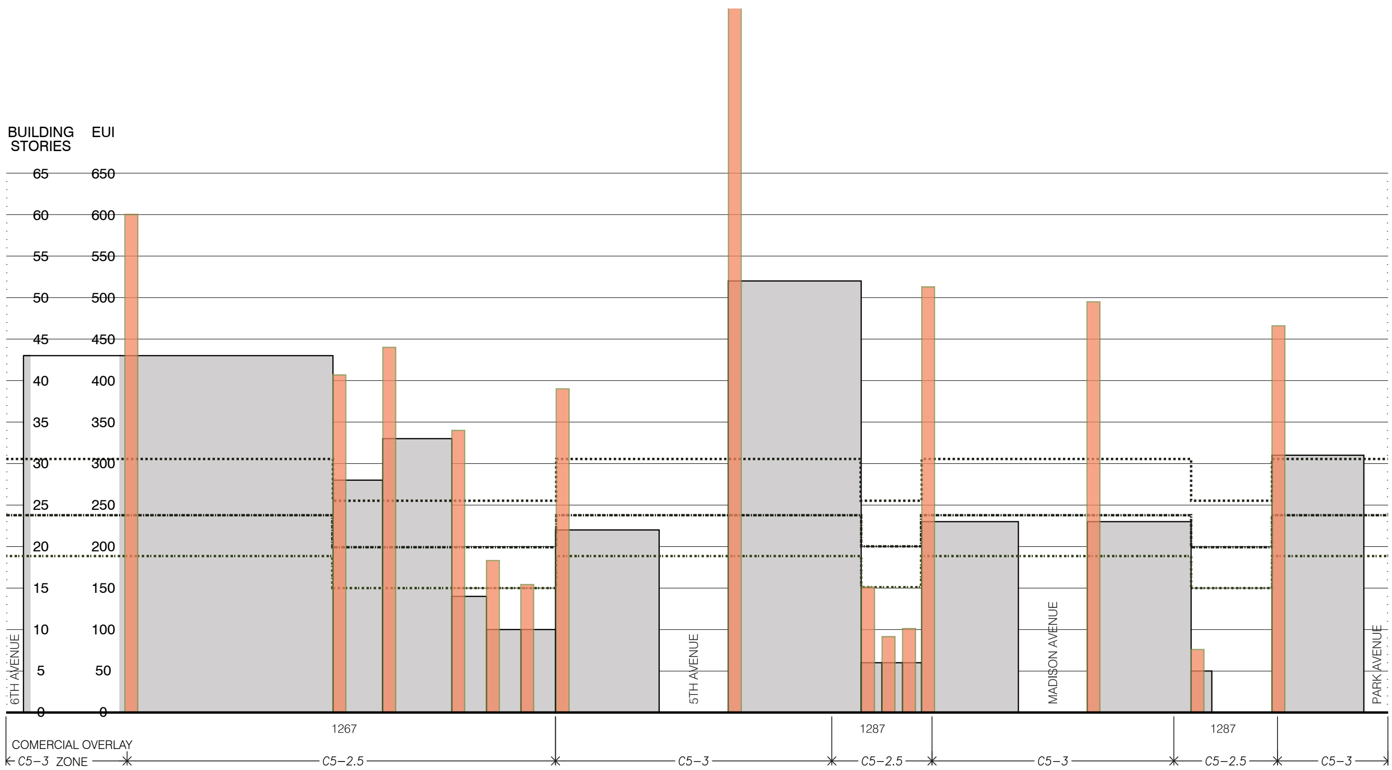
CARBON OVERLAY ZONING in NEW YORK CITY

A proposed framework for implementation

March 7, 2012



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Author's Note and Acknowledgments

This project grew out of my participation in a 2009 project of the New York City Bar Association's Real Estate Committee to suggest changes to the New York City Zoning Resolution. While many of the changes recommended by the Committee were taken up by the City as a part of its Zone Green text amendment, a Carbon Overlay the subject of this paper was not. At the time, there were many barriers to implementation, and no consensus could be reached in the short time available to discuss the possibilities. Since that time, I have worked on-and-off on the project, and have finally reached a point where it is possible to present the idea in its currently developed state.

Much of the substance of the thought behind the work herein comes through my work as principal at Cycle Architecture, PLLC, where we have frequently been called upon to assess zoning and development feasibility for our clients. Caleb Knutson made an invaluable contribution to organizing and presenting data and graphics. Numerous people were willing to listen to me describe the concepts presented here, and I am thankful for the opportunity their critical thinking gave me to refine these thoughts.

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Introduction

Applied innovation is the only way that our cities can effect a major transformation in the way buildings are constructed and operated. If ambitious carbon reduction targets are to be met and surpassed, incremental improvements and implementing operational efficiencies will not by themselves be sufficient. They are not intended to produce anything other than incremental change.

It is also not sufficient to rely on goodwill and a "virtuous circle" of competition to drive innovation. While competition to build and operate the greenest buildings may indeed spring from a few innovative builders and designers, such isolated efforts will not be enough to change the way we build. In order to impact building practices across cities, the definition of "conventional" construction and building operations will need to change to incorporate innovative techniques and technologies. It is not just the leaders who must embrace innovative design and construction practices, the laggards must change as well. A transformative change with such reach can only be accomplished through application of regulation that binds all to a higher standard.

Innovation has typically relied on the personal efforts of individual visionaries and risk takers. One reason for this is that the cost of innovation is high, especially in highly regulated building environments such as cities. Market pressures constantly force development into the "tried and true." Construction becomes a commodity, and people who finance construction have limited means of quantifying anything that is not market tested. Furthermore, regulators often do not have the knowledge or authority to review or approve innovative designs. Invariably, attempts at innovation are met with great institutional resistance, which is why many innovative projects are developed in a vacuum.

It is the purpose of this study to identify and explore a way to reward innovation in construction and renovation of buildings which could rapidly reduce energy consumption by buildings in the City. The Carbon Overlay, a regulatory and zoning framework, would reward innovation with a zoning bonus, and would provide numerous benefits to the City as well as to developers. This study investigates the feasibility and potential operation of such a framework, offers conclusions about implementation, and outlines additional research to validate the concept.

Carbon Overlay Zoning

Carbon Overlay Zoning would associate energy use standards with traditional zoning rules based on floor area, bulk, and unit density. Coupled with other building code enforcement mechanisms including energy benchmarking, a carbon overlay would be used to encourage resilient low energy development through zoning bonuses, tax abatements, or administrative relief. A carbon overlay zoning framework would encourage innovations to reduce building energy use. At the same time, disincentives such as tax penalties could be applied to non-conforming, energy-wasting buildings.

Using a crosstown street in Midtown Manhattan as a sample area for study, this white paper aims to establish a workable framework for a carbon overlay for New York City. Elements of the framework would include methods for establishing energy use intensity standards for typical building types, as well as for correlating energy use intensity to zoning districts and to individual lots. In addition, the study proposes a way to set bonuses for performance that can be measured in terms of energy use, zoning floor area, and the financial bottom-line. Finally, the project illustrates some potential applications for the carbon overlay framework applied to hypothetical developments.

The essence of a carbon overlay zoning and planning framework is to assign an allowance for energy use to each lot in the City. Where current zoning rules govern building bulk on the basis of context and location within the city, a carbon overlay would add energy use as a means to govern bulk. A carbon overlay zoning framework would provide a way to construct a larger building on a zoning lot provided that the building used less energy than allowed for the lot.

A carbon overlay would be used in a number of ways to establish policies that would benefit the city, including benefits to citizens, businesses, and city government. For example the city could allow a bonus for energy efficiency in the amount of floor area permitted on a zoning lot. This bonus would be pegged to code mandated energy performance and could be utilized until eventually zero energy buildings are required by code at some point in the future.

The Concept of a Carbon Overlay

The concept of an “overlay” is well established in New York City zoning laws. For example, there are “commercial overlay” districts, which allow for legal commercial uses within residential districts. The commercial overlays are usually situated along major thoroughfares, ending within 100 feet of the corner, so that the side streets remain exclusively residential. This form, a commercial strip with residences on the side streets, is a typical characteristic of many parts of New York City including residential portions of Manhattan and throughout the boroughs.

A commercial overlay district does not restrict the underlying residential regulations. Rather, it allows an additional class of development and alternate uses and occupancies. Within such a district, a builder may elect to build commercial, residential, or mixed-use properties.

A carbon overlay would operate in a similar way to a commercial overlay. The underlying zoning regulations would remain in effect and would be unchanged. When new buildings are constructed or existing buildings are renovated, overlay regulations would require energy upgrades and would allow a bonus for high efficiency construction.

Like the overlay, the bonus is well established regulatory method in New York City zoning laws. For example, in order to promote street level open space, the 1961 zoning resolution allowed additional floor area for buildings with public plazas in dense commercial districts. The plaza bonus promoted a particular building typology in favor among leading architects and planners in the postwar era, and resulted in the many public plazas with tall modernist towers that characterize parts of Midtown Manhattan today.

A bonus for energy efficiency would operate in a similar way to the plaza bonus. Where a building met basic energy efficiency criteria such as those mandated by building laws, there would be no bonus. However, if a building's energy efficiency exceeded performance requirements by a significant or substantial margin, then there would be a bonus granted.

In order to be effective, the carbon overlay would rely on a measure of building energy use, the Energy Use Intensity factor, or EUI.

Benefits

If additional floor area could be developed on a site in exchange for lower energy use, there would be many benefits for building owners, city residents, utilities, and the City government.

For building owners

- Faster return on investment.
- Monthly income would be higher
- The expense ratio would be lower.
- Project financing barriers would be lowered
- The construction would ultimately be more valuable since high performing buildings are better assets.

For city residents and businesses

- Increased demand for local green design and construction expertise.
- Increased economic activity
- Workforce development in green technologies

For utilities,

- Stabilizing influence on utility grid, with more reliable power at less expense,
- Loosening of demand for new power sources in and around the City.

For the City,

- Increase the tax base,
- Low cost of implementation, very little direct funding required, if any
- Advancing policy objectives meant to encourage green building practices.
- Positions the City as a center for cutting edge green technology.

Applying the concept of a Carbon Overlay to the NYC Zoning Resolution

All buildings use energy, and the City has moved aggressively to manage and regulate building energy use. It has been widely reported that buildings account for 90% of electricity use in New York City, and 75% of greenhouse gas production. The City's Greater Greener Buildings plan has charted a course to improve the City's building and energy codes and other city rules with the goal of improving overall building energy performance. The city's target of an 80% reduction in greenhouse gas emissions by 2050 will only be achieved if there are stringent measures undertaken to improve energy performance.

A building's energy performance can be identified by its Energy Use Intensity (EUI) factor, a factor which correlates units of energy use to units of built area. EUI is typically expressed in terms of kWh/SF or Btu/SF or their metric equivalents, and the higher the EUI, the more energy use per square foot. EUI can be calculated simply from meter readings of actual energy use and measurements of a building's actual floor area.

Therefore, once a building's EUI is determined, building energy use may be translated further into a quantity of power per year allotted to a particular zoning lot as per Equations 1 and 2.

Equation 1

Building Energy Use / Building Floor Area = Building EUI

Equation 2

Building Energy Use / Lot Area = Zoning Lot EUI

In addition to these simple calculations, there would likely be a number of variables to consider for implementation. For example,

1) EUI per building may vary depending on the use of the building,

2) Mixed use buildings with high intensity ground floor uses will have higher EUI,

3) EUI per building may vary depending on the age and construction of the building.

4) Submetering could help establish a building's use classification, as well as determine the building's energy use.

Establishing a Target

As the saying goes, what you can measure, you can manage. Once EUI is measured for any building or zoning lot, it can be regulated. Target EUI values can be assigned for any building or zoning lot, and a number of management tools – both incentives and penalties, can be applied to encourage better building performance.

For most common building types a corresponding EUI can be developed on the basis of ASHRAE 90.1 2010 or New York City Energy Conservation Construction Codes. These codes mandate minimum energy performance standards for buildings for purposes of determining code compliance. Compliance is determined either prescriptively or through controlled performance modeling against a minimum complying "base building."

Building energy performance modeling and simulation is a standardized practice documented in ASHRAE 90.1 Appendix G. It is used throughout the construction industry both to demonstrate compliance with Building Codes (including the NYC Energy Code) and for third party certifications, such as LEED™. While it has been observed that energy modeling is not an entirely accurate predictor of actual building performance, if coupled with benchmarking and reporting, it can be used as part of a regulatory system, such as the proposed Carbon Overlay.

By designing a "base building" in compliance with ASHRAE 90.1 standards, it is possible to forecast energy use, and hence derive an EUI factor for a minimum, code complying building. Once the energy use of a code complying building is calculated, a "code complying" EUI can be assigned for a particular building type.

While development of EUI levels for code compliance is beyond the scope of this study, it is necessary to suggest initial EUI levels for purposes of testing the concept of the carbon overlay. Fortunately, there is a basis for initial assignment of EUI's for various building types. ASHRAE has developed a set of 16 Reference Buildings in 16 U.S. locations for purposes of researching new technologies. http://www.nrel.gov/docs/fy11osti/46861.pdf While these buildings are not intended to represent energy use in any particular building, the ASHRAE reference models are well documented "hypothetical models with ideal operations that meet certain minimum requirements." They can be used for research purposes in order to develop this concept for regulation. If the City were to implement a carbon overlay, there would need to be a similar effort to develop EUI criteria specific to buildings in New York.

With a "code minimum" EUI developed and assigned to a variety of building types, it is possible to arrive at a standard EUI for zoning lots. Building EUI would be utilized in coordination with zoning bulk and floor area regulations to determine the maximum allowable energy use for any particular zoning lot. This could be calculated as indicated in equation 3.

Equation 3

Zoning Lot EUI (ZEUI) = Allowable Building Energy Use / Lot Area

Where

Allowable Building Energy Use = Code-Complying Building EUI x Maximum Allowable Zoning Floor Area

For most zoning lots in NYC, a "maximum building" can be hypothesized based on the zoning regulations. In fact, a review of zoning feasibility is a typical feature of any due diligence for land acquisition and development. If energy use were regulated by the zoning resolution, it would become a part of the due diligence currently practiced by building owners and developers.

For example:

> Given a lot of 5,000 Square Feet in the R8B zoning district, zoning regulations allow a mid-rise residential development of 20,000 Square Feet up to 80 feet in height. For the sake of argument, a basic code complying mid-rise residential building might have an EUI factor of 12.2 kWh per year per square foot. This would indicate annual energy use of 244,000 kWh per year for the building.
>
> Hypothetically, under a carbon overlay zoning scenario, this value, 244,000 kWh per year, or 12.2 kWh/SF/yr, would represent a baseline for compliance. Yet, it would also be possible for the City to set a level for a bonus. This bonus level EUI factor would need to be set much lower than minimum code compliance, and would reward greater energy efficiency with greater floor area, while keeping energy use for the lot at a substantially lower level. While the building would be larger, there would be less energy used on the lot.

By applying this framework to all properties in the city, a carbon overlay could be developed and implemented.

Feasibility of a method for defining the parameters of a potential "carbon overlay."

As noted earlier, the actual levels used in calculating carbon overlay bonuses will be critical to implementation. In conventional zoning practice, determination of allowable bulk is mathematical and quantitative, based on simple calculations. There are numerous factors applied in zoning calculations, including floor area ratios, density factors, lot coverage percentages, sky exposure planes, and street wall factors. Each factor is set at a level which prescribes a required level of performance.

The art of zoning regulation is found in the application of level setting. There is a social dimension to zoning regulation and the question of degree is critical to any zoning standard. For example: how much floor area is appropriate for a given area? How tall is tall enough for a building? Likewise, if EUI is to become a factor for determining the size of buildings, the question would be: what is a fair EUI criterion for each zoning district and building type? Level setting by utilizing the ASHRAE reference buildings or other simulated data would not be sufficient to determine EUI, since simulation data (however accurate) is always somewhat disconnected from reality. A hard look at existing development and energy use patterns would be required to set code-complying. However, for purposes of this study, we have done exactly that – used ASHRAE referenced buildings - in the absence of real-world data.

In order to test the concept of a carbon overlay based on real world conditions, a "transect" consisting of all the lots on the north side of a cross-town street traversing Midtown Manhattan from river to river was analyzed. This particular transect was selected due to the variety of building types found on the street, and the relatively low number of churches, synagogues and other difficult-to-classify building types. There are residential, commercial, and manufacturing zones represented, mostly in medium and high densities.

Data for each of the 129 zoning lots in the sample area was compiled from public records and maps, and summarized on a spreadsheet. In addition, Maximum Floor Area ratios were assigned to each zoning lot based on the NYC Zoning Resolution, and the Maximum Allowable Floor Area was calculated for each lot.

In addition, each zoning lot was assigned an EUI based on building typology and age. Data was input from calculations based on the EUI from the ASHRAE Reference Buildings for the following building types:

- Large Office Building
- Large Hotel
- Medium Office Building
- Full service Office
- Mid-rise Apartment Building
- Supermarket
- Stand Alone Retail

On the basis of these data, several factors were calculated, and plotted on a visual representation of the transect for analysis, (Appendix A, Figures A)

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Spatial Assessment of Energy Use:

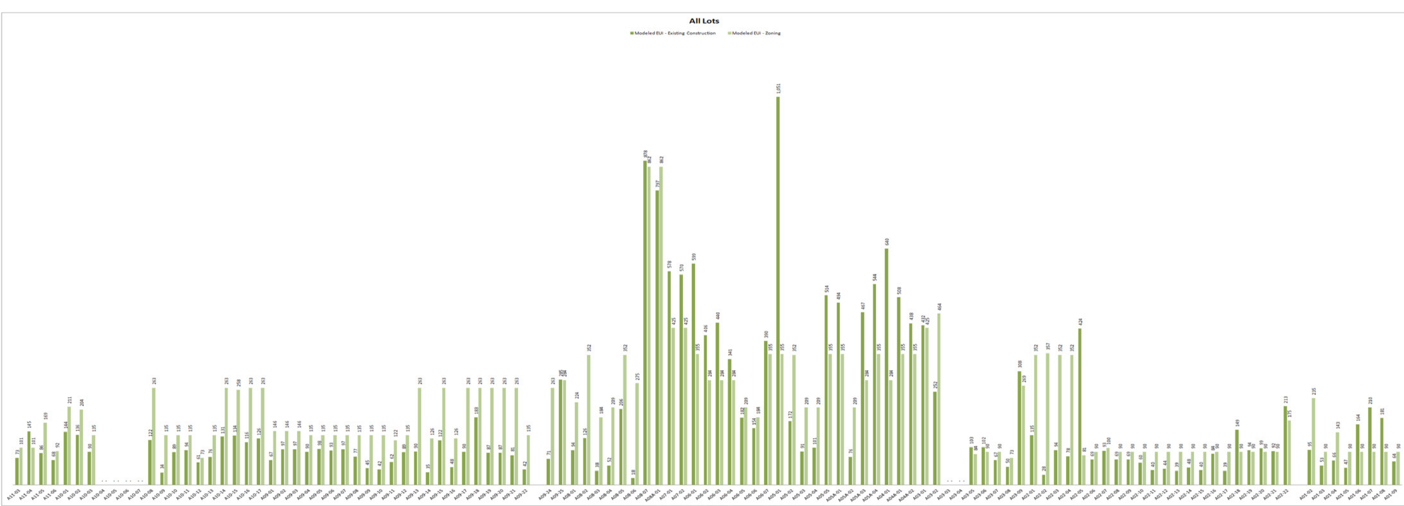
A central feature of the approach used is that EUI can be associated with a zoning lot, and visually associated with a measure of energy (the energy use bar on the chart) to effectively provide a means for a spatial assessment of energy consumption. By plotting energy use on top of the transect, we can find a way to visually describe energy use. There are other ways to show energy use spatially, and this is an area for further research. A recent Columbia University study of energy use based on statistical analysis used a color coded map to illustrate energy use on a given block, and to predict EUI on a given lot based on building typology and age.

However, zoning applies individually to structures on each zoning lot, so aggregated statistical analysis is of limited use. In addition, each zoning lot has its own unique development history. Many zoning lots have structures that do not comply with zoning regulations, are oversized, or are undersized. It is important to consider these factors in developing a zoning concept that would be applied in the imperfect, exception-filled world of New York real estate.

The task of setting EUI factors for purposes of a carbon overlay would require detailed and careful study of energy use patterns throughout the city. However, with energy benchmarking of many New York City buildings now mandated, there will soon be a reliable dataset for purposes of performing such a study.

Table 1 indicates an initial summary of the transect sites. There are a number of zoning districts represented across the transect, each with its own predominant use and criteria for floor area. The table shows a basic Floor Area Ratio (FAR) for each zone based on NYC Zoning Regulations and a predominant use based NYC Zoning Regulations, City records, and visual review of the sites.

ASHRAE reference buildings were used as a basis for establishing EUI for each building in the sample, and multiplied by the allowable zoning FAR to set an EUI level for the site. By proposing a "bonus" level of performance for each building we are also able to set a bonus EUI level for each zoning district. In this case, we set the bonus level at 25% better than code. As a point of reference this level of performance is roughly equivalent to earning 8 of a possible 19 LEED points for energy efficiency (EA Credit 1).



LEVEL SETTING Table 1: Transect Zone Summary – Initial EUI Levels for Compliance (kWh per Square Foot)							
Zone	R8B	R8	R10	M2-4	C1-9	C6-4, C5-2.5	C6-5, C6-6, C6-7, C5-3.5
FAR Basis	4	6.02	10	5	10	10	15
Predominant Use in Sample	RES	RES	RES	COM	RES	COM	COM
EXISTING BUILINDGS							
Building EUI from ASHRAE Ref. Buildings	25.83	21.26	17.65	25.67	17.65	25.5	25.5
Site EUI Level based on Existing Construction ($MEUI_{EC}$)	103	128	177	128	177	255	355
PROPOSED CONSTRUCTION – Baseline required for bonus							
Code Complying Building EUI	12.20	12.20	12.20	14.77	12.20	20.05	20.05
Threshold Building EUI Proposed for Bonus	9.15	9.15	9.15	11.08	9.15	15.04	15.04
Threshold Site Proposed EUI Level for bonus ($MEUI_{PZ}$)	37	55	92	55	92	150	226
*Energy Use Reduction**	64%	57%	48%	57%	48%	41%	36%

*Compared to existing construction

1. The table does not account for zoning floor area bonuses earned for public plazas or similar bonuses.
2. The EUI for existing buildings and construction is based on ASHRAE Reference Buildings built in accordance with ASHRAE standard 90.1 1989.
3. The EUI for proposed construction is based on ASHRAE Reference Buildings designed to ASHRAE 90.1 2004 standards.
4. ASHRAE reference buildings differentiate between mid-rise and high rise construction for both residential and office uses, which may account for differences in EUI in zoning districts.

Bonus Level Setting

A bonus is only as useful as it is available. If the bonus threshold is set too high, then people will not take advantage of it. If the bonus threshold is set too low, then everyone will be able to achieve a bonus and it is not really a bonus at all.

First, a bonus should only be available to those properties that perform substantially better than standard “code minimum.” For purposes of this study, we established a bonus threshold for Building EUI at 25% better than code.

Next, the size of a bonus should reflect building performance, with a better performing building receiving a more generous bonus. Finally, a levels should be set to promote innovation. While the levels indicated in this study illustrate the concept of a Carbon Overlay, there are more detailed sophisticated statistical analyses that could be performed to yield better and more consistent levels.

The Level setting chart diagram (Figure B) shows two levels of site energy use: basic code compliance and a threshold level for receiving a bonus. Zoning Floor Area is plotted against an EUI factor for the site. The lower the EUI factor, the higher the bonus.

The Level Setting Spreadsheet (Table 2, on the following page) indicates calculations of bonus floor area for zoning districts in the transect based on hypothetical levels of performance. These are typical of the calculations that would be used by developers to understand the capacity of any given zoning lot. These zoning floor areas and energy efficiencies would inform development pro-formas and financial modeling performed by the developer to demonstrate project viability.

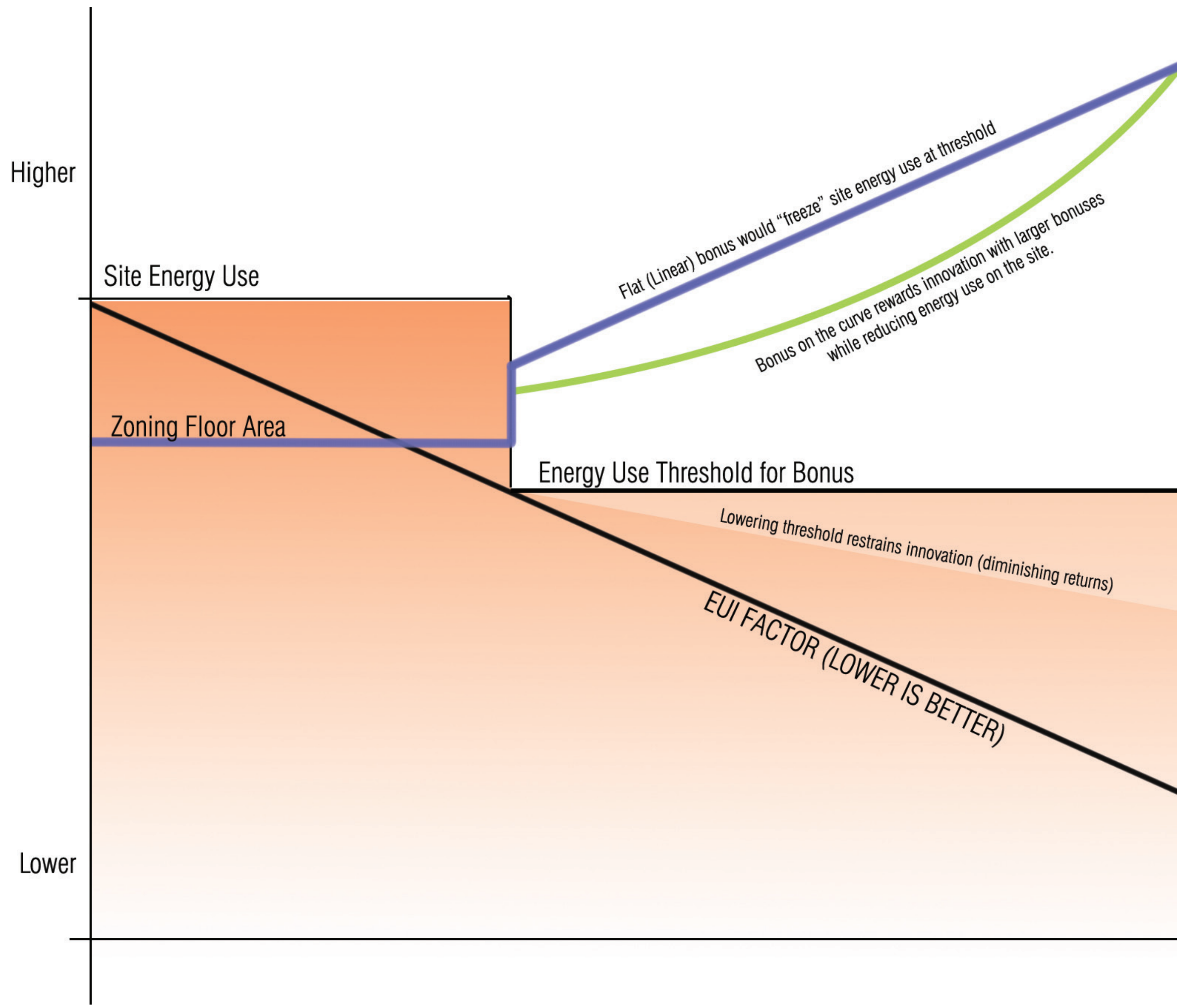
Barriers and Challenges to Implementation

While a carbon overlay zoning program would be aligned with the City’s aims for energy efficiency in buildings, and much of the data required for implementation either exists or is currently being compiled, there would be challenges to overcome in implementing such a program.

There is, for example, the complexity of the “underlay.” New York City has nearly 1 million buildings and the zoning regulations are copious and extensive. Any program requiring a change to the zoning involves a substantial amount of research, and would need to be validated by real data. As this study indicates, the availability of data would be critical to the development of an enforceable zoning framework that would award a bonus for energy efficiency.

Benchmarking would be a key element of any enforcement policy. Without real-world data to back up design claims, any zoning bonus would become the province of a mandarin-like class of energy modeling specialists. However, since many buildings are now required to benchmark their energy use, there is a built-in mechanism to ensure compliance. The proof of performance will be in energy bills that are easily understood rather than in complex building energy simulation models. As a corollary, additional control over both building performance and energy use can be put in place by requiring sub-metering of individual tenant spaces.

With regard to permitting, current protocols at the Department of Buildings concerning design review and inspections would need to be modified, but only slightly. As it stands, whole building energy simulations can be used to demonstrate compliance with the New York City Energy Code. In addition, special inspections of construction are required to docu-



FIBURE B. LEVEL SETTING CHART DIAGRAM

ment compliance with Energy Code requirements. Modeling requirements and calculations for the Carbon Overlay could be added to the existing protocols governing energy code compliance.

As a consequence of new requirements, some additional training would need to be provided to Department of Buildings plan examiners and staff in order to implement the bonus framework. However, there would be very little else in the way of public expenditure to implement the program. There would be no incentive pay-out required, or tax abatement. In fact, because property values would likely rise, tax collections could increase as a result of the program.

With regard to enforcement, thanks to the City's energy benchmarking requirements, it will be possible to substantiate whether a building meets EUI levels as designed to claim the bonus. A project's failure to meet approved energy efficiency targets given a bonus could be handled in many ways:

- Denial or revokation of Certificate of Occupancy. A certificate of occupancy could be denied until designed energy efficiency is achieved.
- Tax penalties. Owner's of buildings that fail to meet approved energy efficiency targets could be made liable for additional taxes.
- Owner actions, including partial disassembly of the building to affect compliance, or purchase of EUI rights from adjacent developments.

Since the bonus program would be a voluntary program, with the risks and rewards of entering into the program clearly spelled out. We would need to assume that any developer who pursued the bonus would be aware of the consequences of failure.

The size and value of any bonus would need to be sufficiently lucrative to encourage participation in the program. There are many possible benefits that could be awarded by the City to developers pursuing a carbon overlay bonus.

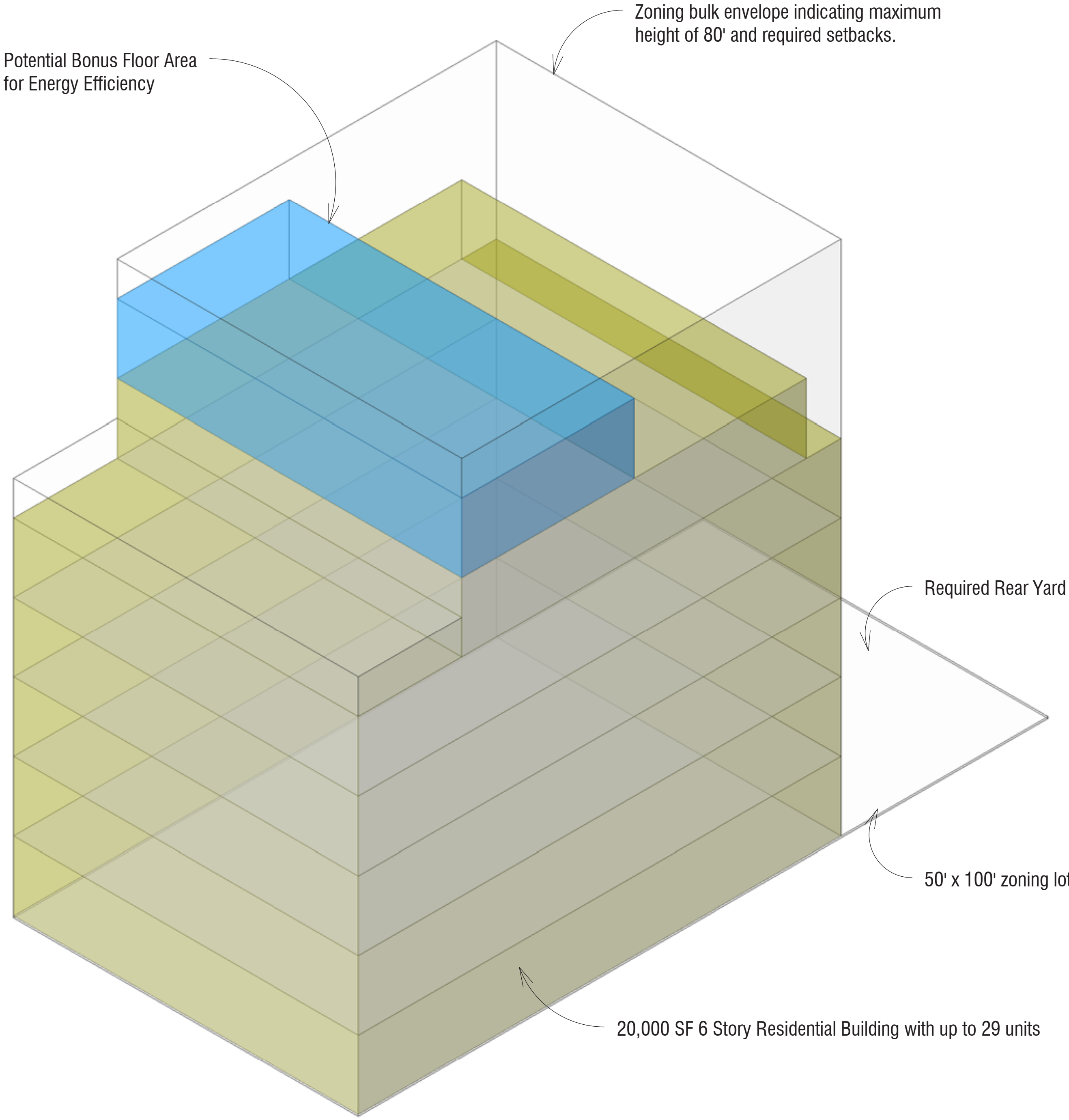
- Additional floor area could be awarded. This would be quite lucrative, especially for larger projects.
- Permitting could be accelerated, although there would need to be a fairly substantial penalty for failure to deliver, since this benefit would quickly accrue to any developer.
- A tax incentive could be offered, although in theory, the energy efficiency measures undertaken to achieve the bonus would provide a similar sort of relief in lowered annual expenses and a higher Net Operating Income.

Case Studies: Hypothetical applications

Given the level setting exercise described above, we analyzed applications of a zoning bonus for hypothetical projects in some of the sample zoning districts. The case studies below are intended to reveal the possibilities for development using a carbon overlay for zoning, and to suggest a basis and format for zoning calculations using a carbon overlay.

TABLE 2: BONUS CALCULATIONS: TRANSECT (TRIAL RUN)

Lot Size (SF)	5000		5000	5000	5000	5000		5000	5000
Zone	R8B	R8A	R8	R10	M2-4	C1-9	C6-3/R9	C6-4	C6-6
As-of-right FAR	4		6.02	10	5	10		10	15
As of right Max. FA	20,000		30,100	50,000	25,000	50,000		50,000	75,000
Base EUI	12.2		12.2	12.2	14.77	12.2		20.05	20.05
Base Energy	244,000		367,220	610,000	369,250	610,000		1,002,500	1,503,750
Building EUI Threshold Proposed for Bonus	9.15		9.15	9.15	11.08	9.15		15.04	15.04
Site Proposed EUI Level for bonus	36.6		55.08	91.5	55.39	91.5		150.38	225.56
Site Proposed EUI Level for bonus with intensive first floor use	86		104	141	104	141		199	275
Total Site Energy Ceiling	183,000		275,415	457,500	276,938	457,500		751,875	1,127,813
Energy Improvement	25%		25%	25%	25%	25%		25%	25%
1% Better than Threshold		**Better than Code**			**26%**				
Hypothetical Building EUI	9.06		9.06	9.06	10.97	9.06		14.89	14.89
Curve Factor	0.70		0.70	0.70	0.70	0.70		0.70	0.70
Energy Bonus SF	141		213	354	177	354		354	530
Max. Allowable FA with Energy Bon	20,141		30,313	50,354	25,177	50,354		50,354	75,530
Max. Gross FAR	4.03		6.06	10.07	5.04	10.07		10.07	15.11
Site Energy	182,451		274,589	456,128	276,107	456,128		749,619	1,124,429
10% Better than Threshold		**Better than Code**			**33%**				
Hypothetical Building EUI	8.24		8.24	8.24	9.97	8.24		13.53	13.53
Curve Factor	0.75		0.75	0.75	0.75	0.75		0.75	0.75
Energy Bonus SF	1,667		2,508	4,167	2,083	4,167		4,167	6,250
Max. Allowable FA with Energy Bon	21,667		32,608	54,167	27,083	54,167		54,167	81,250
Max. Gross FAR	4.33		6.52	10.83	5.42	10.83		10.83	16.25
Site Energy	178,425		268,530	446,063	270,014	446,063		733,078	1,099,617
20% Better than Threshold		**Better than Code**			**40%**				
Hypothetical Building EUI	7.32		7.32	7.32	8.86	7.32		12.03	12.03
Curve Factor	0.80		0.80	0.80	0.80	0.80		0.80	0.80
Energy Bonus SF	4,000		6,020	10,000	5,000	10,000		10,000	15,000
Max. Allowable FA with Energy Bon	24,000		36,120	60,000	30,000	60,000		60,000	90,000
Max. Gross FAR	4.80		7.22	12.00	6.00	12.00		12.00	18.00
Site Energy	175,680		264,398	439,200	265,860	439,200		721,800	1,082,700
50% Better than Threshold		**Better than Code**			**63%**				
Hypothetical Building EUI	4.58		4.58	4.58	5.54	4.58		7.52	7.52
Curve Factor	1.00		1.00	1.00	1.00	1.00		1.00	1.00
Energy Bonus SF	20,000		30,100	50,000	25,000	50,000		50,000	75,000
Max. Allowable FA with Energy Bon	40,000		60,200	100,000	50,000	100,000		100,000	150,000
Max. Gross FAR	8		12.04	20	10	20		20	30
Site Energy	183,000		275,415	457,500	276,938	457,500		751,875	1,127,813



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Axonometric View - R8B Residential Zone

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Carbon Overlay Zoning

New York, NY

Project number	A0521
Date	DRAFT
Scale	

FIG. C

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Case Study 1: Residential Development, R8B Zoning District

Figure C shows a typical residential development within the R8B Zoning District. The figure indicates the limits of the development in terms of bulk and floor area, and shows a possible "bonus" in terms of the amount of floor area.

As demonstrated above, the floor area of the project could be increased, while the overall energy use of the building could be decreased. As a result, we can conclude:

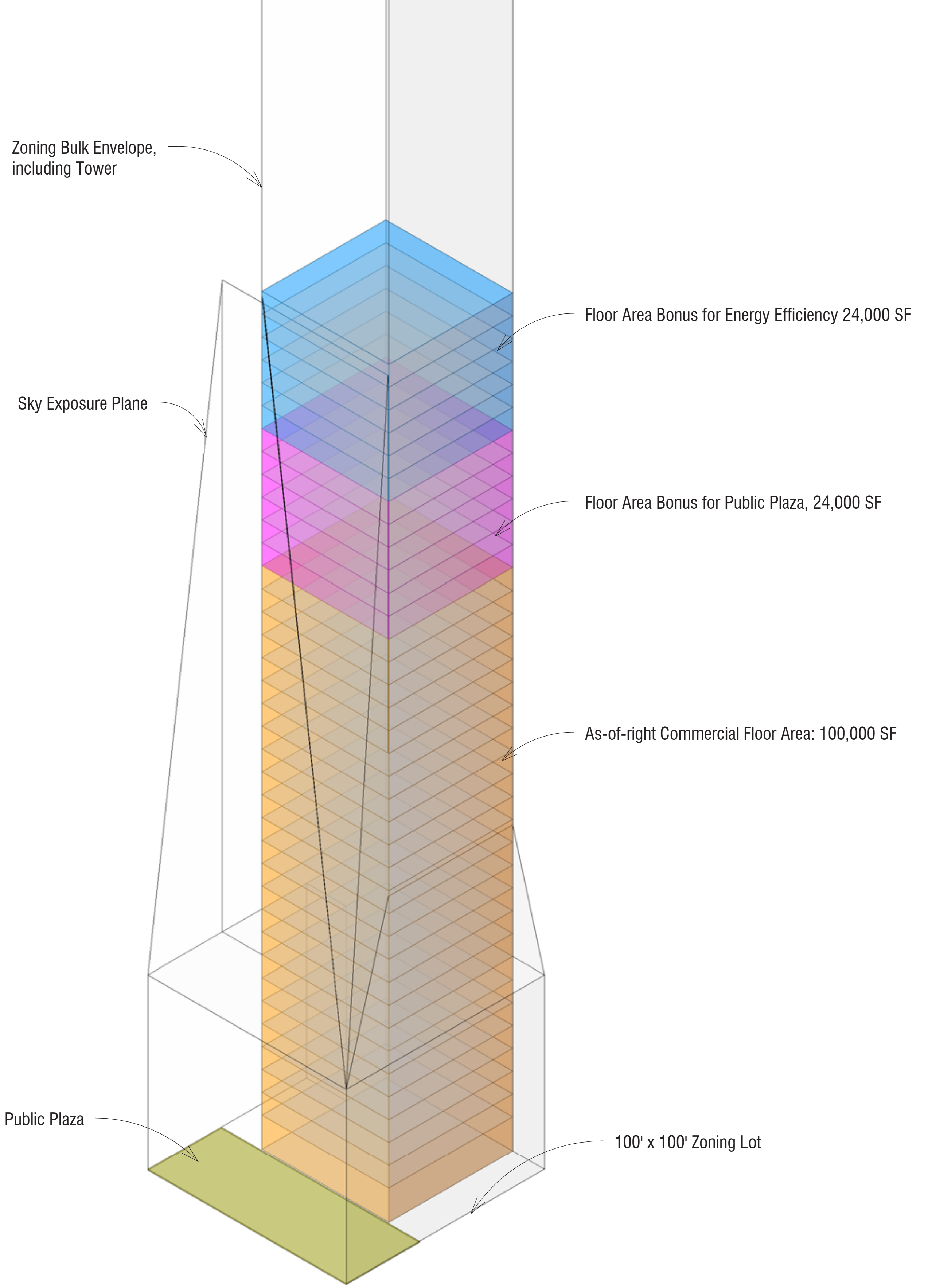
1. Design and Construction costs for the development would be higher by approximately 8.33%.

2. Annual energy costs for the development would be lower by approximately 27%

3. Annual rents for the development would be higher by approximately 10%

4. The City's tax base would be higher, since the value of the land would be increased.

	Development Description
Site	50' x 100' lot, 5,000 SF total.
Zone	R8B
Max. FAR	4.0
Max. Zoning Floor Area	20,000 SF
Maximum Building Height	60' Base Height, 80' Building Height
Density Factor	680 SF/Dwelling Unit
Maximum # of Dwelling Units	29
Project Description	Mid-rise residential development. Standard housing stock, possibly subsidized or set-aside on the basis of income.
	"As-of-right" Energy Use
$\boldsymbol{MEUI_{Ez}}$	12.2 kWh/sf/yr
$\boldsymbol{MEU_{Ez}}$	244,000 kWh/yr
	Bonus Calculation (33% Better than Code)
Proposed FAR Bonus	0.33
Max FAR with Bonus	4.33
Max Floor Area with Bonus	21,667 SF
Max. # of Dwelling Units	32
$\boldsymbol{MEUI_{PZ}}$	8.24 kWh/sf/yr
$\boldsymbol{MEU_{PZ}}$	178,425 kWh/yr



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Commercial Development - C6-4 Zone

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Project number	A0521
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FIG. D

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Case Study 2: Commercial Development, C6-4 Zoning District

Figure D shows a potential tower development on a 10,000 SF lot. The figure indicates the limits of the development in terms of height, lot coverage, and plaza area, and shows the application of two bonuses – one for a public plaza and one for energy efficiency.

As demonstrated above, the floor area of the project could be increased, while the overall energy use of the building could be decreased. As a result, we can conclude:

1. Design and Construction costs for the development would be higher by approximately 15%.
2. Annual energy costs for the development would be lower by approximately 25%
3. Annual rents for the development would be higher by approximately 16%
4. The City's tax base would be higher, since the value of the land would be increased.

	Development Description
Site	100' x 100' lot, 10,000 SF total.
Zone	C6-4
Max. FAR	10.0 + Bonus for Plaza (6 SF per 1 SF of Plaza Area)
Proposed Plaza	4,000 SF (40' x 100')
Max. Zoning Floor Area	100,000 SF + 24,000 SF
	124,000 SF
Maximum Building Height	Unlimited (tower)
Project Description	High-rise commercial development, normal office uses.
	"As-of-right" Energy Use
$MEUI_{Ez}$	20.05 kWh/sf/yr
MEU_{Ez}	2,482,200 kWh/yr
	Bonus Calculation
Proposed FAR Bonus	2.5 (in addition to Bonus for Plaza)
Max FAR with Bonus	12.5 + Bonus for Plaza
Max Floor Area with Bonus	149,000 SF
$MEUI_{PZ}$	12.44 kWh/sf/yr
MEU_{PZ}	1,853,560 kWh/yr

Conclusions

This white paper set out to propose a scheme for a “carbon overlay” for building and zoning in New York City, and attempted to outline, quantify and test a potential application of such a scheme. While many facets of a carbon overlay zoning scheme and the mechanics of its operation were identified, additional research and study would be needed in order to implement such a scheme.

Suggested areas of research include, but would not be limited to:

- Modeling base building types within NYC
- Level setting for bonuses
- Feasibility of application in lower density zones
- Feasibility of application to smaller buildings
- Cost studies and cash-flow analysis for building owners.
- Financial analysis for tax policy

In addition, the scheme as implemented would need to be compatible with the existing built and regulatory environment in New York. There would be many challenges, but the scheme draws upon the existing infrastructure of the city, both built and regulatory. The challenges to implementation would be in marshaling the political will to implement it, and forging a consensus among stakeholders to commit to it. Despite these policy challenges, based on this study, the mechanics of a carbon overlay seem to be manageable.

The benefits to a carbon overlay zoning framework would be many. Value would be created for both the City and property owners through promotion of energy efficiency in such a way that the “size of the pie” would be increased. Tax revenue would go up, while operating expenses for building owners including energy expenditures would be go down. Opportunities would be created for the type of development that benefits the city. Urban density would be increased on the condition that energy use would decrease.

By implementing a carbon overlay, the City would create a new class of assets – carbon or energy based development rights. Policies could be developed to grant those rights, transfer them between properties, and collect taxes on value created by the additional rights. Policies could also be calibrated to promote the City’s green construction and workforce development objectives, or to reward exceptional building performance. A carbon overlay zoning scheme could have a positive impact on the City’s life without punishing citizens or businesses or draining the city’s coffers. It merits further study, and consideration for implementation.

Appendices

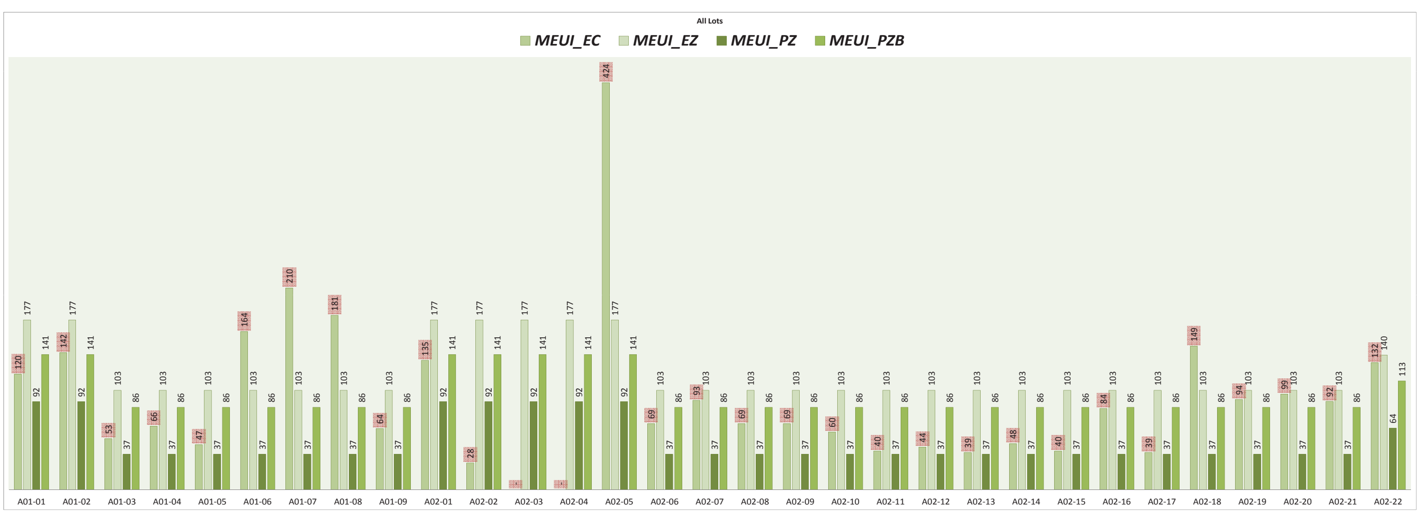
A. Transect Charts and Energy Use Terminology
B. Regulatory Process Notes

The Transect Charts

Based on the criteria of Table 1, the accompanying charts illustrate an initial assessment of the potential for a carbon overlay. The charts indicate the transect, running from West to East. Buildings are represented as solid grey areas roughly scaled to the building height in stories and lot frontage along the transect street. Energy use intensity is plotted as an orange bar at each building. Horizontally, lines across the page indicate EUI levels proposed for various scenarios.

The chart makes it possible to see whether a building would be in compliance with a particular energy requirement, and to assess the degree of non-compliance. In addition, it allows a reviewer to make an informed judgment about either a building's energy performance, or (in this case) whether the proposed requirements are reasonable. The transect charts illustrate the potential for applying a "carbon overlay", and in their development, several qualities of a potential overlay came to light.

- Opportunity exists: Many buildings are older, and presumably many buildings operate inefficiently.
- Allowances need to be made for building use. It is not sufficient to attach an EUI to a zoning district alone. Many zoning districts allow for a variety of different uses, each with its own energy profile. Some uses such as supermarkets and restaurants use considerably higher amounts of energy and it makes sense to allow for a limited amount of additional EUI on lots with those uses.
- Development size figures prominently in a calculation of EUI, due to the sensitivity of the zoning calculations. In other words, any bonus or regulation scheme would need to be weighted or leveled in its application, because smaller projects would experience the bonus differently from larger projects.



Data Extracted from Sample - Excel Chart

Energy Use Terminology, (total building energy use, kWh)

There are several ways that we must address EUI relative to both buildings sites in order to consider a carbon overlay. Therefore, for purposes of clarity and consistency, we utilize the following terminology in the white paper and on the Charts.

MEU_{EC} Modeled Energy Use, Existing Construction

Calculated on the basis of existing gross floor area from city records and Energy Use Intensity derived from ASHRAE Reference Buildings (based on ASHRAE 90.1 1989 Standards, or when buildings pre-date 1980, on earlier reference standards)

MEU_{Ez} Modeled Energy Use, Existing Zoning

Calculated on the basis of Maximum Allowable Zoning Floor Area and Energy Use Intensity derived from ASHRAE Reference Buildings for new construction (ASHRAE 90.1 2004).

MEU_{PZ} Modeled Energy Use, Proposed Zoning

Calculated on the basis of Maximum Allowable Zoning Floor Area and Energy Use Intensity derived from ASHRAE Reference Buildings for new construction, modified to be more efficient

MEU_{PZC} Modeled Energy Use, Proposed Zoning with High Intensity Commercial Use at Ground Floor

Calculated on the basis of Maximum Allowable Zoning Floor Area and Energy Use Intensity derived from ASHRAE Reference Buildings for new construction, modified to be more efficient, and with an allowance for high energy intensity use (supermarket, restaurant) at ground floor

Energy Use Intensity Terminology, (energy use per unit of lot area, expressed as kWh/sf/year)

$MEUI_{EC}$ Modeled Energy Use Intensity, Existing Construction

*Calculated by dividing **MEU_{EC}** by the lot area.*

$MEUI_{Ez}$ Modeled Energy Use Intensity, Existing Zoning

*Calculated by dividing **MEU_{Ez}** by the lot area*

$MEUI_{PZ}$ Modeled Energy Use Intensity, Proposed Zoning

*Calculated by dividing **MEU_{PZ}** by the lot area*

$MEUI_{PZC}$ Modeled Energy Use Intensity, Proposed Zoning with High Intensity Commercial Use at Ground Floor

*Calculated by dividing **MEU_{PZC}** by the lot area*

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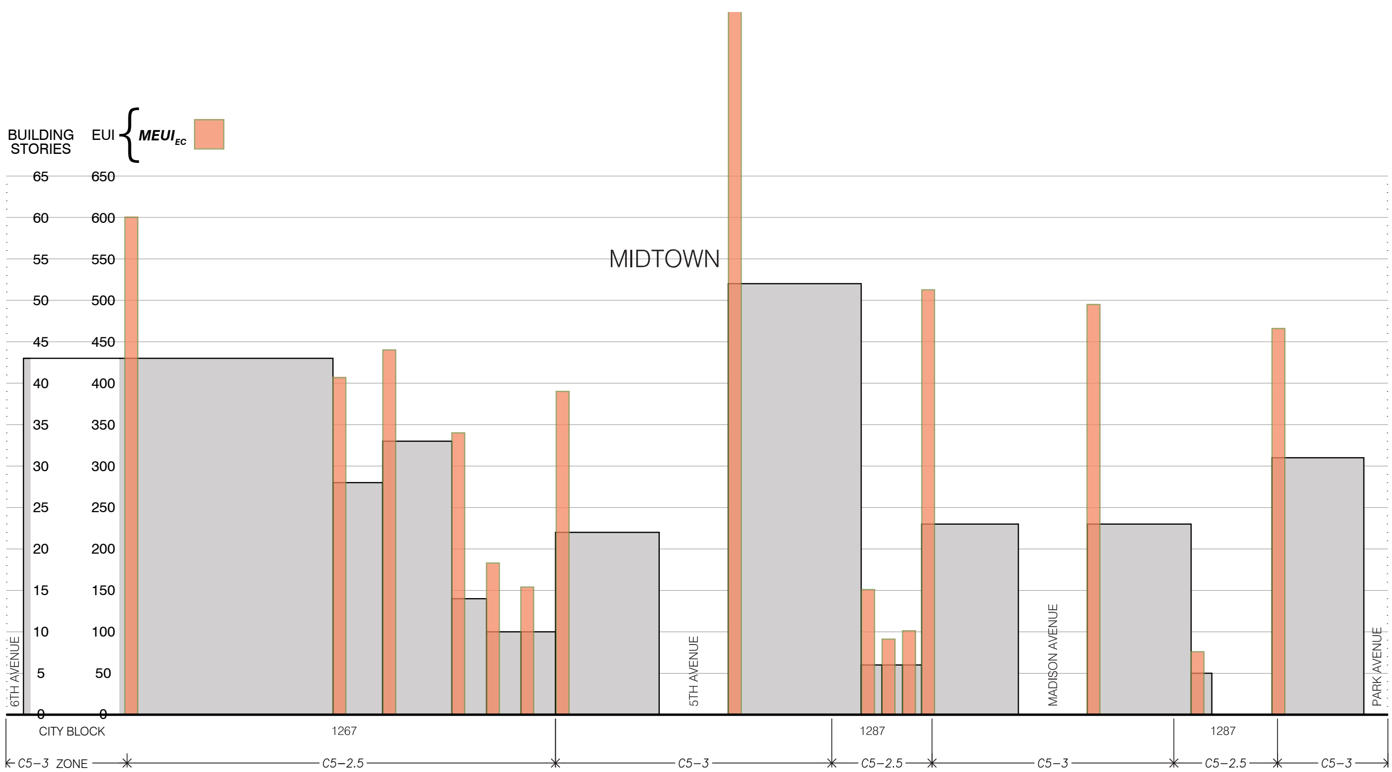

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Existing Construction and Energy Intensity - Midtown

FIG. A

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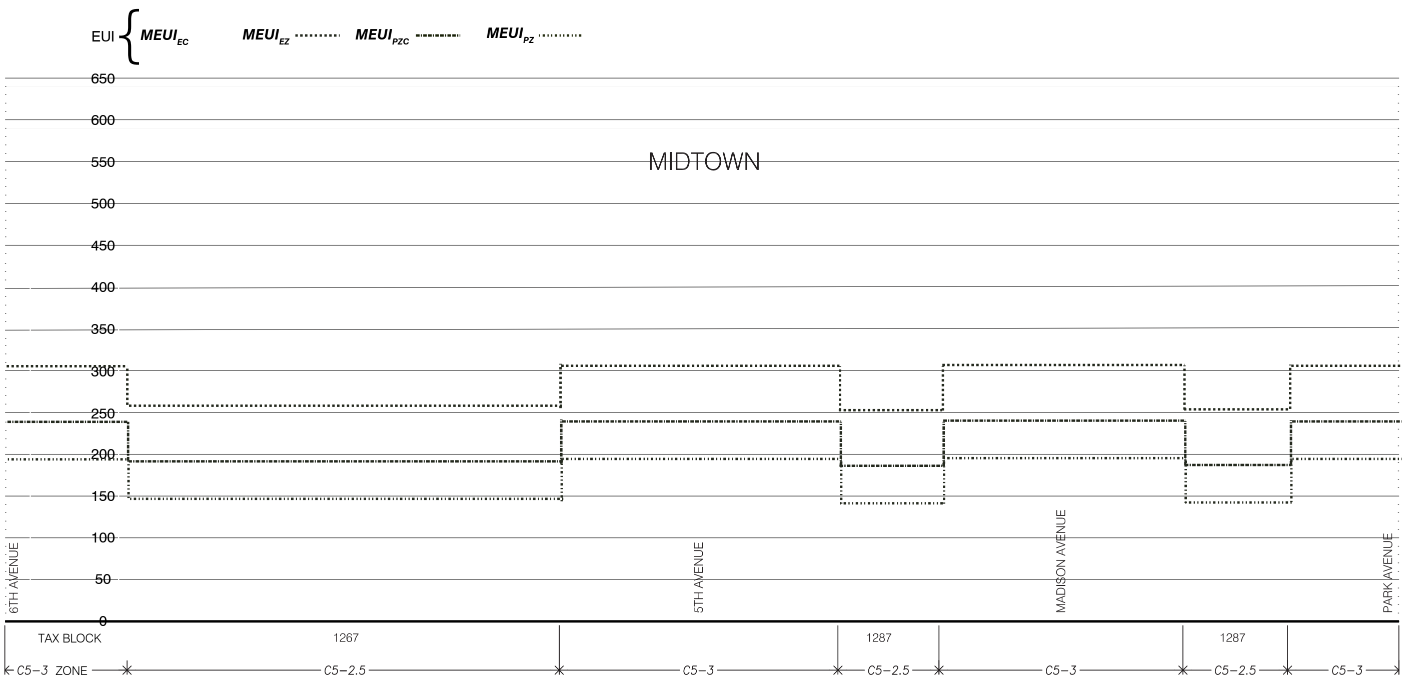

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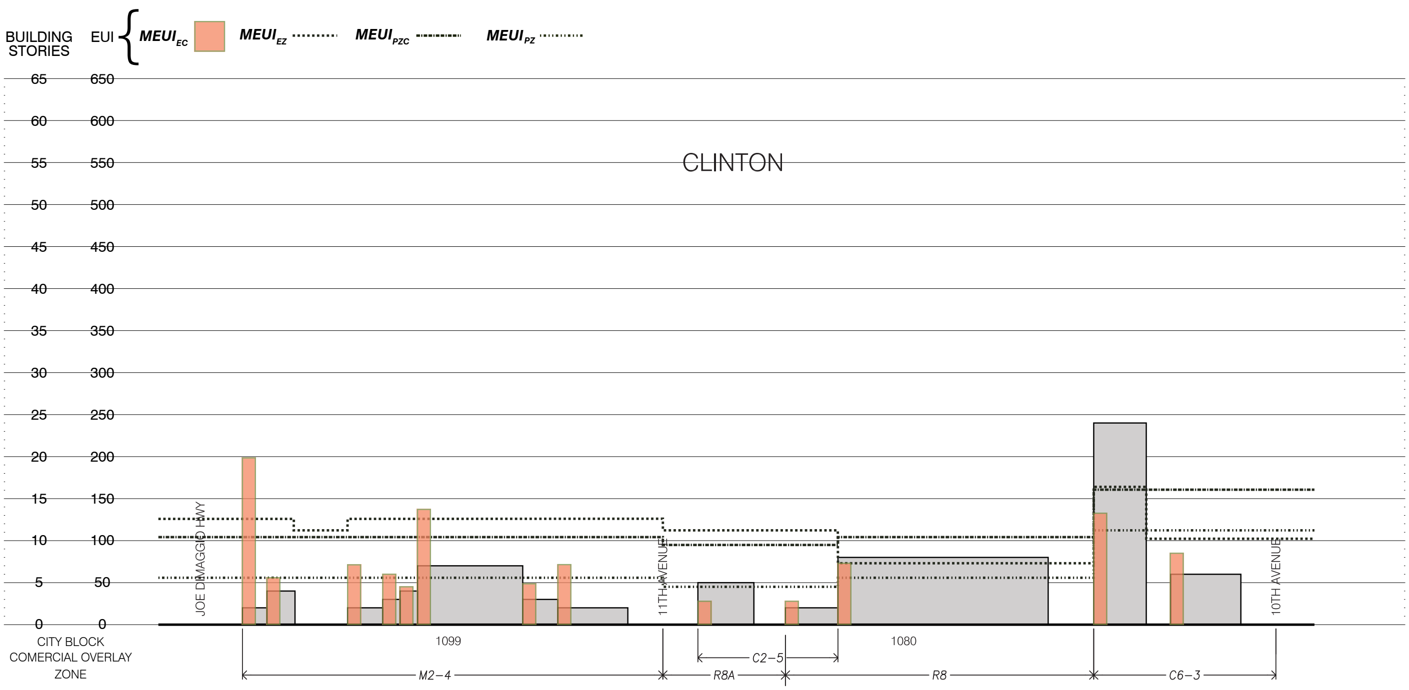
ENERGY INTENSITY - PROPOSED LIMITS - MIDTOWN

FIG. A



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ENERGY INTENSITY - EXISTING CONDITIONS AND PROPOSED LIMITS - CLINTON WEST

FIG. A

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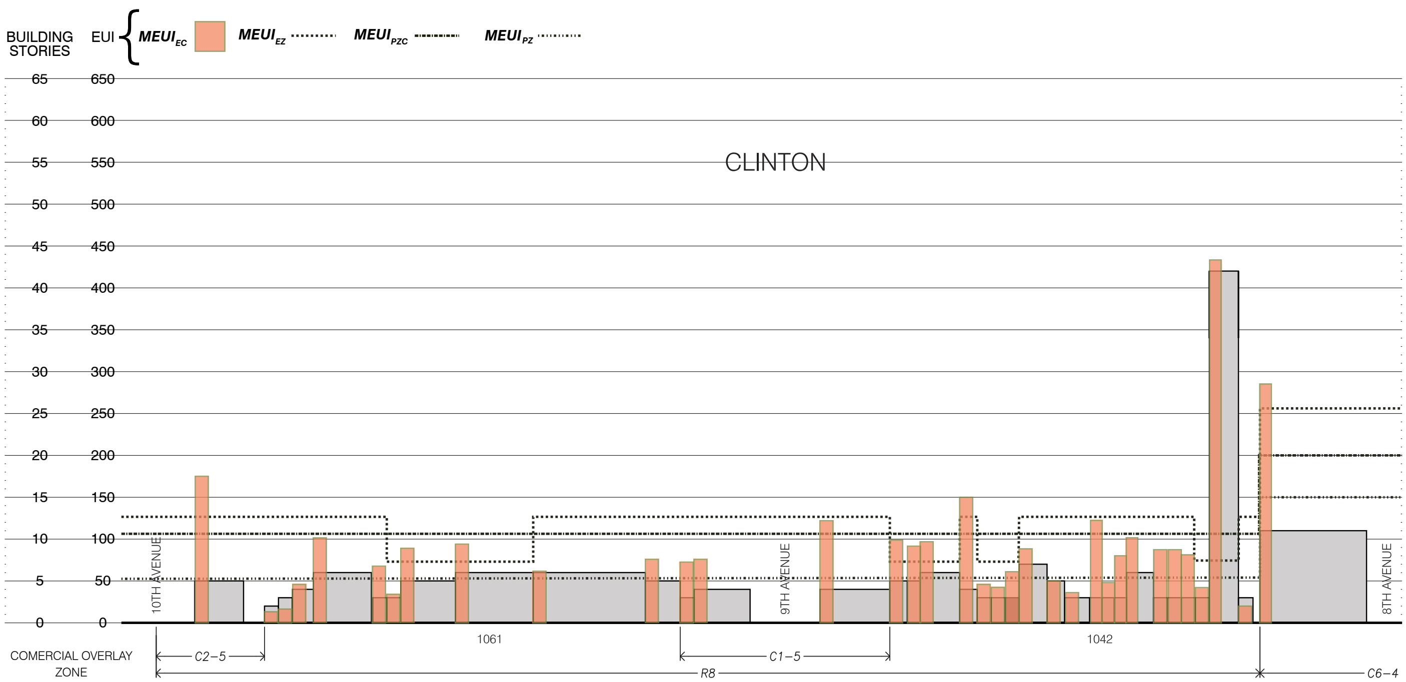

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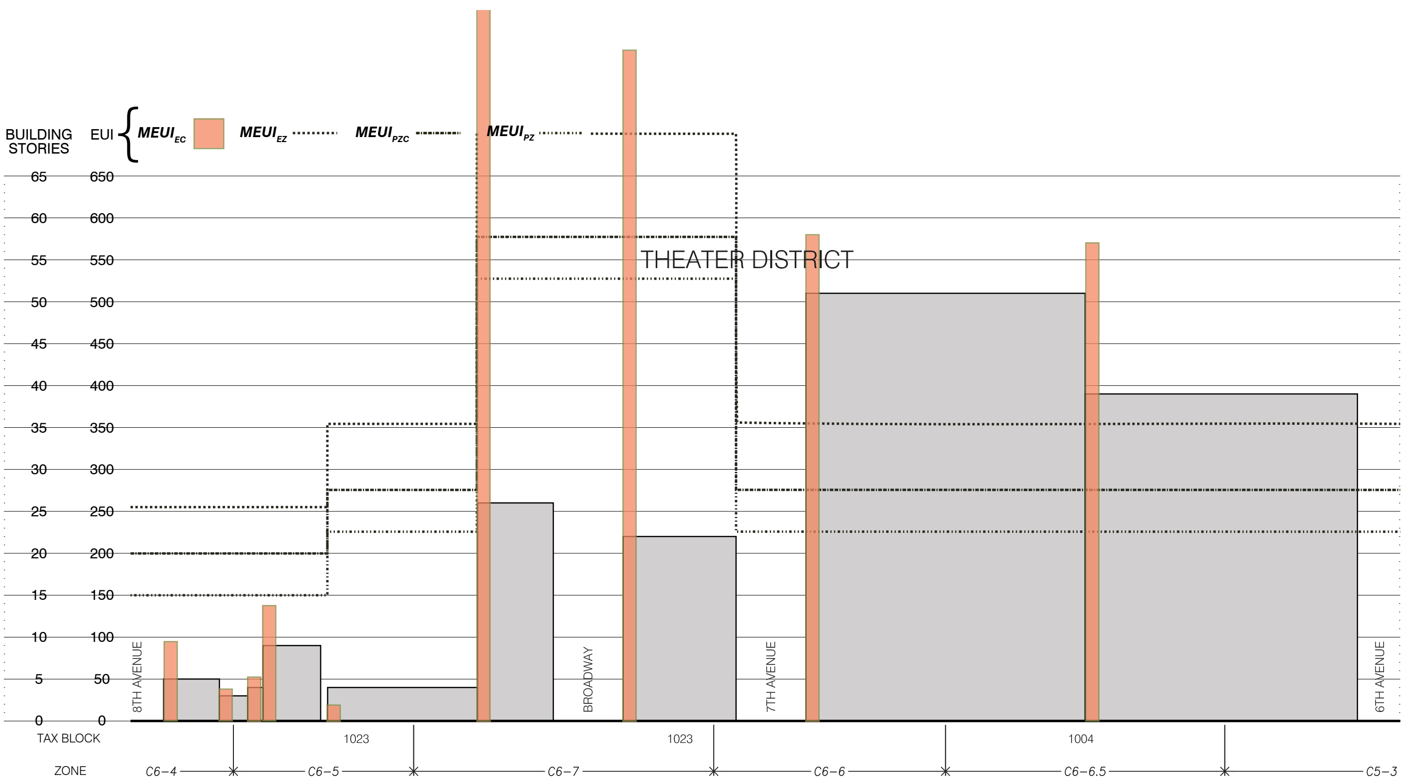
ENERGY INTENSITY - EXISTING CONDITIONS AND PROPOSED LIMITS - CLINTON

FIG. A



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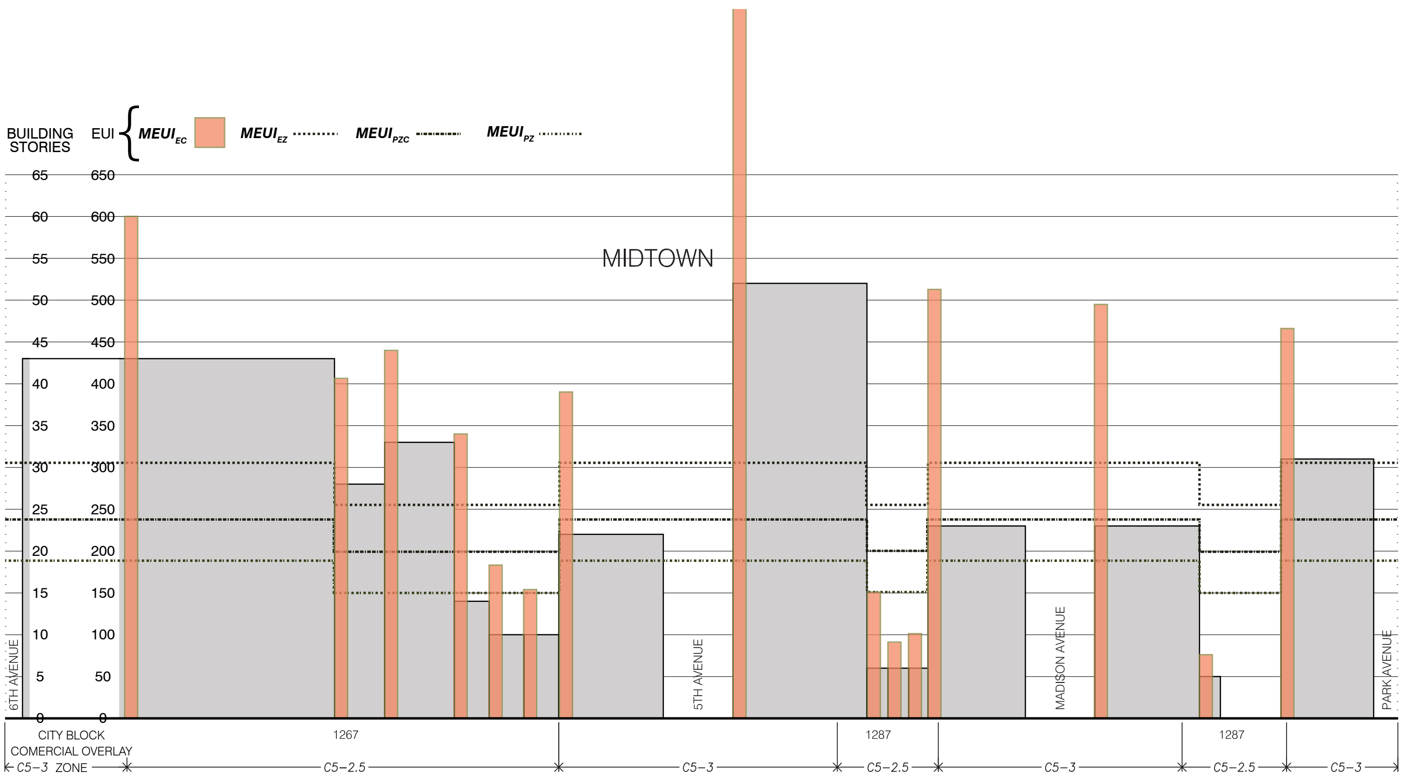
ENERGY INTENSITY - EXISTING CONDITIONS AND PROPOSED LIMITS - THEATER DISTRICT

FIG. A



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ENERGY INTENSITY - EXISTING CONDITIONS AND PROPOSED LIMITS - MIDTOWN

FIG. A

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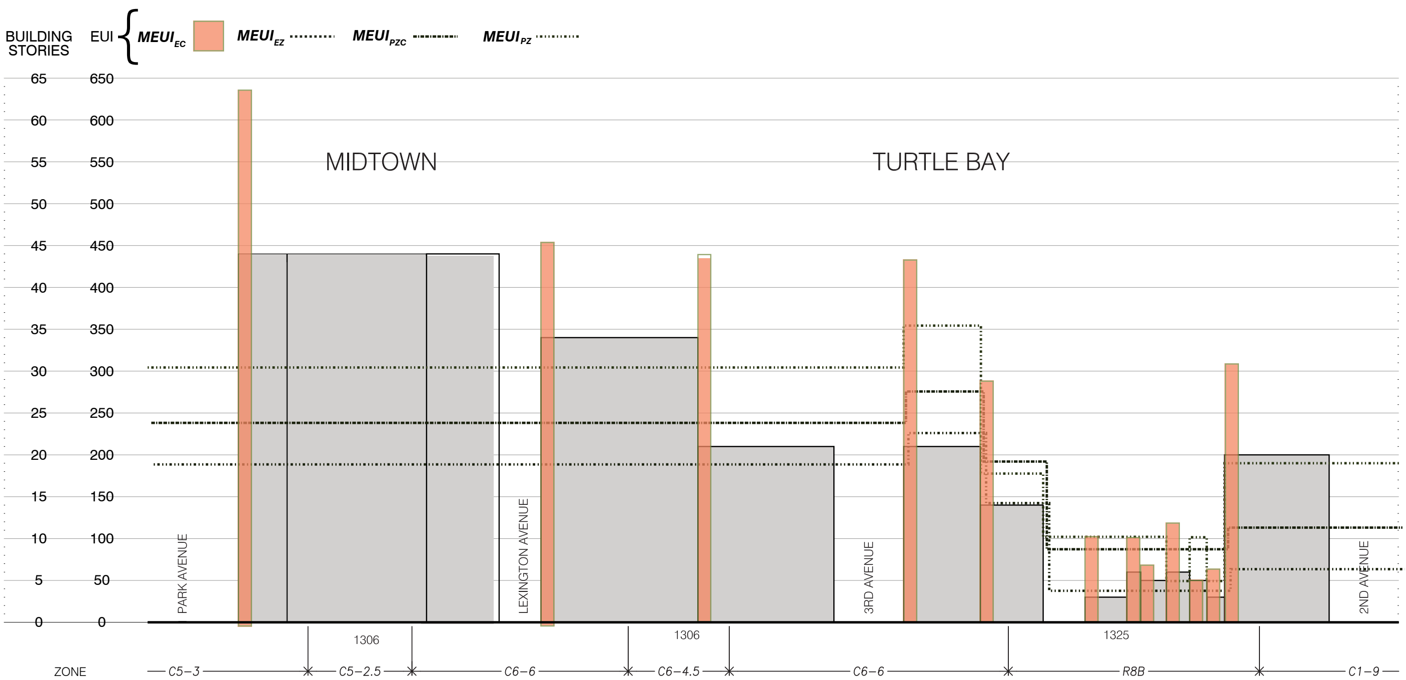

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ENERGY INTENSITY - EXISTING CONDITIONS AND PROPOSED LIMITS - TURTLE BAY WEST

FIG. A

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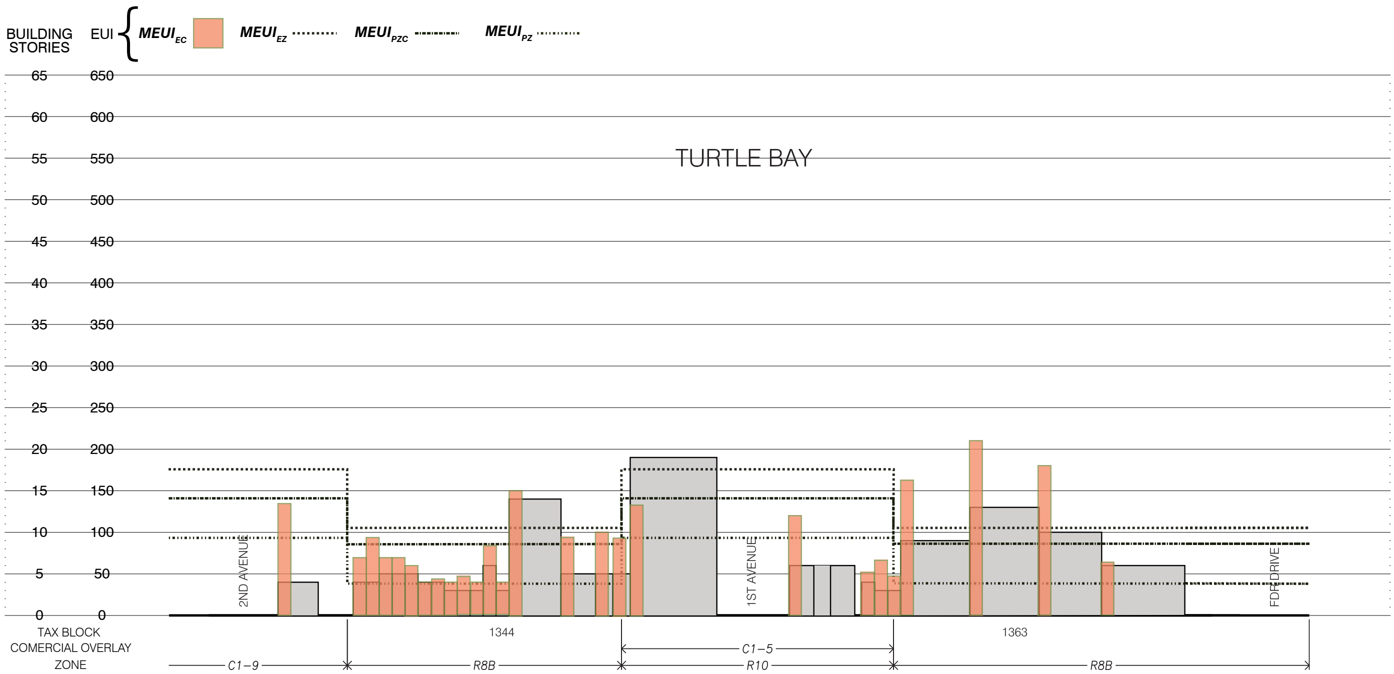

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ENERGY INTENSITY - EXISTING CONDITIONS AND PROPOSED LIMITS - TURTLE BAY EAST

FIG. A

About the Charts

The charts (Figures A) indicate zoning lot EUI, approximate building height, and levels for zoning EUI regulations. Existing EUI is estimated, and shown as an orange bar. Through simple observation, it is possible to discern which buildings comply or are not in compliance with proposed regulations. We were interested in seeing the degree of non-compliance with existing standards for a number of reasons:

1. We wanted to see the extent of non-compliance. Levels for compliance, (or for bonuses, or for penalties,) would need to be set so as to have the best effect for the City.
    a. If only a few buildings were impacted, it would be both unfair and ineffective.
    b. If every building were impacted, some by a lot, it would be unfair because it would force the risk of extensive building renovation for compliance on many who are unwilling to take risks. This situation would be little more than a new tax or mandate, and as such would do little to encourage innovation.
    c. The ideal level for compliance would be set so that compliance would be easy, non compliance would be tractable, and a bonus would be available for those who so chose to pursue it.
2. We also wanted to see the distribution of non-compliance, and which buildings did not comply.
    a. While establishing rules based on data is useful, more can be learned by identifying exceptions.

Appendix 2: Regulatory Process Notes

Building energy use is regulated by the City's Building and Energy codes, and by means of other Local Laws. When buildings are constructed or renovated, they must be brought into compliance with the New York City Energy Conservation Construction Code. Compliance may be demonstrated prescriptively, through the installation of materials and equipment that meet mandated performance standards, or through the preparation of whole building energy models using approved energy simulation software (DOE-2, Energy Plus, eQuest, etc.) Documents signed and sealed by a registered architect or licensed professional engineer attest to a building or project's compliance with Energy Code, and are filed for approval.

Once a building is complete, it must benchmark its energy use in accordance with a series of local laws. Energy benchmarking is required because it provides building owners with a basis for making energy efficiency improvements in equipment and operations. While repairs are not mandated under the city's benchmarking laws, it is reasonable to surmise that once building owners are able to identify operational savings that "pay for themselves," they will act out of enlightened self-interest to make energy efficiency improvements to their buildings.

With energy modeling for compliance during design and benchmarking and reporting during the operation of a building, it is possible to rate a building's energy use. There are already many ways of doing this. For example, the Federal Government's Energy Star™ program utilizes a master set of data (CBECS) to rate buildings compared to other buildings of similar type and vintage. A building's Energy Star score refers to its percentile ranking compared to other buildings of its type in similar climactic locations.