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THE NEIGHBORLY SUBSTATION

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Electricity, Zoning, and Urban Design

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FOREWORD

In 1879, the remarkable thing about Edison's new lightbulb was that it didn't burst into flames as soon as it was lit. That disposed of the first key problem of the electrical age: how to confine and tame electricity to the point where it could be usefully integrated into offices, homes, and every corner of daily life. Edison then designed and built six twenty-seven-ton, hundred-kilowatt "Jumbo" Engine-Driven Dynamos, deployed them in lower Manhattan, and the rest is history. "We will make electric light so cheap," Edison promised, "that only the rich will be able to burn candles." There was more taming to come first, however. An electrical fire caused by faulty wiring seriously damaged the library at one of Edison's early installations—J. P. Morgan's Madison Avenue brownstone.

Fast-forward to the massive blackout of August 2003. Batteries and standby generators kicked in to keep trading alive on the New York Stock Exchange and the NASDAQ. But the Amex failed to open—it had backup generators for the trading-floor computers but depended on Consolidated Edison to cool them, so that they wouldn't melt into puddles of silicon. Banks kept their ATM-control computers running at their central offices, but most of the ATMs themselves went dead. Cell-phone service deteriorated fast, because soaring call volumes quickly drained the cell-tower backup batteries. Traffic lights went dark. The dedicated fiber line that links City Hall to the city's broadcast media went out when a Time Warner hub lost power. The radio communications system for police, fire, and other emergency services progressively lost capacity as the backup batteries for many radio repeaters ran down. Elevator mechanics who happened to be attending a seminar at the New Yorker Hotel in Midtown helped extract guests trapped in the hotel's elevators. Releasing a group stuck in the middle of a twenty-story blind shaft required breaking a hole through a wall on the fifteenth floor.

But enough already on what New York endures when its power occasionally fails. The rest of the story is one of steady economic growth and improving quality of life, made possible by the continuous development of the city's electrical infrastructure. Electricity occupies a uniquely important role in the infrastructure of all of modern society, but nowhere more so than in the heart of the metropolis. It powers all the communications and emergency response networks, hospital emergency rooms, air-traffic control, and street lights, as well as the electrically actuated valves and pumps that move water, oil, and gas. More broadly, electricity energizes every

factory, office, or building that depends on computers, communications systems, pumps, motors, and cooling systems.

Over the course of the last century, electricity progressively superseded other forms of energy at the front end of life, where people turn energy into enterprise, information, entertainment, health care, and hot coffee. This happened because electricity, like a great city, does more, faster, better, in less space. Other energy transmission systems operate at the speed of sound; electricity moves at the speed of light. It is by far the fastest, densest form of power that has been tamed for ubiquitous use.

Year by year, innovation has also allowed increasingly compact transformers, switches, and wires to handle and deliver power more efficiently, quietly, and safely. In power plants, huge, noisy piston engines gave way to compact turbines. The vast spiderweb of overhead electric wires that once canopied the streets of Manhattan went underground. For most city dwellers, electrical infrastructure has gone the way of the Cheshire Cat—everything has disappeared but the smile, the magical outlet that keeps life lit.

And that, ironically, now threatens to make electricity the victim of its own success. Because electricity can so unobtrusively power so much of the city's economy, demand grows in lockstep with the city itself. But because the hardware that supplies the electricity keeps so well out of sight, City Hall tends to keep it out of mind, and city residents reflexively oppose deployment of new electrical infrastructure anywhere near their own lights, toasters, and computers.

As Hope Cohen lucidly discusses in this very important paper, New York can have it all—the power it needs to remain the most vibrant city on the planet, delivered ubiquitously, silently, and invisibly through substations harmoniously integrated into the cityscape. Designed by architects and incorporating modern technology, electrical substations can now have more in common with a telephone exchange or a Web server farm than with a conventional factory or power plant. New York is unusual in having a zoning code so out of touch with the modern realities of electricity. Developers and Con Edison should be allowed to work together to integrate electrical infrastructure into new industrial, commercial, and residential projects. And as other cities have already done, New York should explore possibilities for deploying substations beneath public open spaces.

Such policies would lead to much more efficient, profitable use of immensely valuable land—while maintaining supplies of secure, reliable power, provided by an electrical infrastructure that continues to recede from public sight. Ms. Cohen has it exactly right: "People don't like ugly, scary substations near them. But substations don't have to be ugly and scary. And they do need to be nearby." This paper explains how to turn those three, indubitable facts into practical public policy. New York will grow richer, brighter, and more beautiful when it does.

Peter W. Huber
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Prior to joining CRD, Cohen worked for many years in the city's public sector, in areas ranging from urban planning to capital budgeting to strategic information technology. She was at MTA New York City Transit for over a decade, working for much of that time with power and telecommunications engineers to bring the technology used for New York's subway and bus systems into the twenty-first century. Since 1995, she has supplemented her professional work with voluntary public service as a member of Manhattan's Community Board 7 (Upper West Side), where she has served as land-use cochairperson and board chairperson.

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CONTENTS

POWER TO THE OUTLET!

New York City lives on electricity. The neon lights of Times Square, the subway's third rail, the compact fluorescent bulb in the kitchen of a Bronx apartment, the computers housed in great office buildings—the flow of electrons makes them all possible. Since Thomas Edison turned on the world's first electrical distribution system in 1882, powered by a generating station on lower Manhattan's Pearl Street, the network has expanded outward, upward, and downward, along with the city it powers.

But the hometown of electrical distribution faces obstacles to the further growth of its nervous system. There are serious issues of supply, whether it is generated locally or transmitted from afar. PlaNYC, Mayor Bloomberg's strategy for creating a "greener, greater" New York City by the year 2030, takes on those issues. It proposes building clean generating capacity, providing incentives for exploiting renewable energy sources, and relying more heavily on peak-load management. It goes on to recognize the need to "modernize electricity delivery infrastructure" but does no more than note that "finding locations to site substations in growing neighborhoods is a difficult challenge."[1]

The challenge is difficult because it is multifaceted. The city's zoning regulations prevent optimal siting. And neighbors often object to substations built near them. They fear health consequences and have concerns about noise. Perhaps most important, they object to an ugly, forbidding structure in their midst, deadening street life and reducing property values.

It doesn't have to be that way. Substations are not bad for neighbors' health and do not need to be loud and unattractive. And they ought not use up the city's limited supply of land in the way that they have for the past half-century.

The purpose of this paper is to propose a realistic solution to the problems inherent in substation siting—one that addresses the needs of individual communities, the city's demand for electricity, and the responsibility of Con Edison, the local utility, to deliver power to New Yorkers.

SO WHAT *ARE* THESE SUBSTATIONS, ANYWAY?

An electrical substation houses equipment ("transformers") that "step down" electricity from the high voltages needed for efficient long-distance transmission to the lower voltages appropriate for shorter-distance transmission and for distribution to residential and commercial end users. The other key component of a substation is "switchgear" (sophisticated circuit breakers and switches) to cut power when necessary. These features are supplemented by relays, capacitor banks, and battery backup arrays. There can be several levels of substations stepping down electricity on its trip from generation station to a home or business (see Figure 1, "Power Path"). Ordinary operation of a substation does not require personnel to be on site. Staff manage the equipment in real time from other locations, as substations feature automated systems for fault detection, fire suppression, and remote monitoring and control.

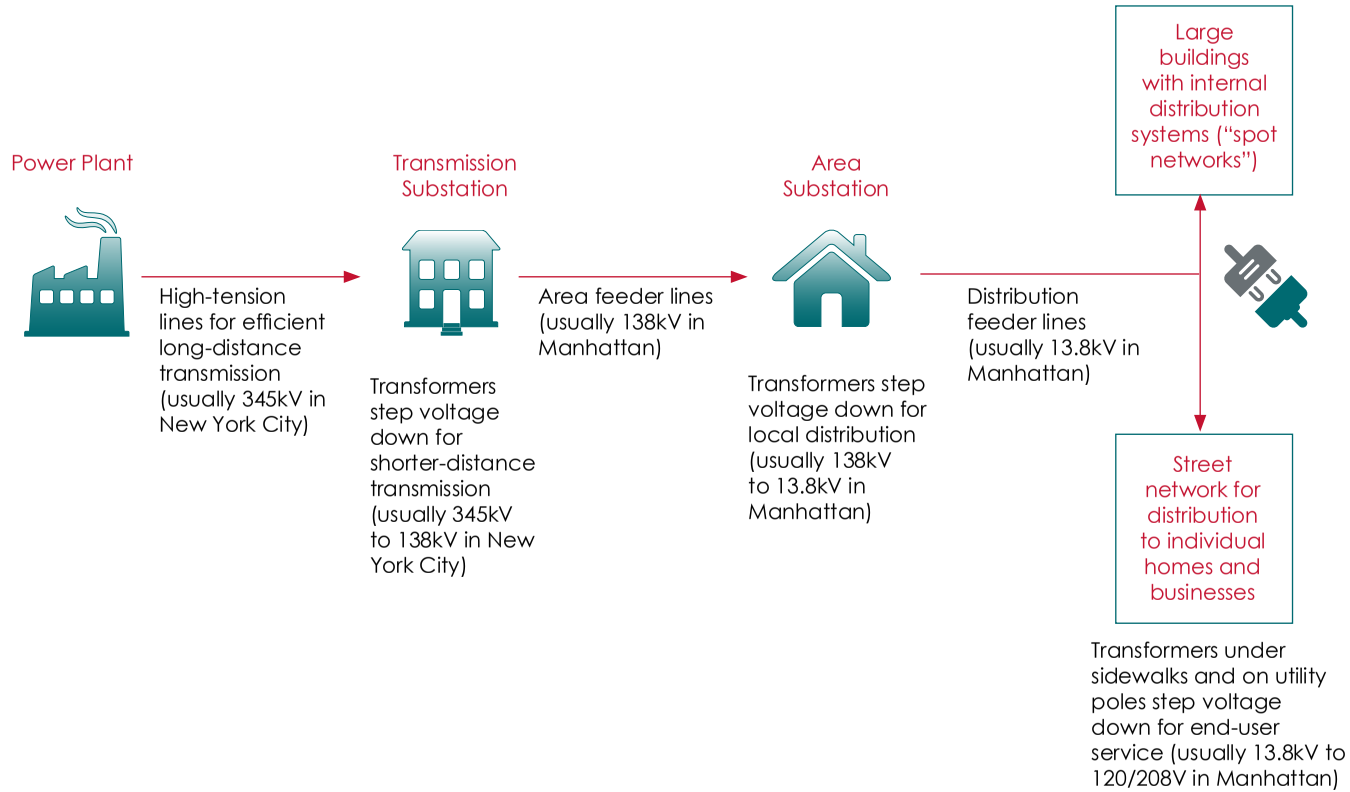
The principal focus of this paper is electric power's last major stop. In New York, it is called an "area substation," and it is where, for service in Manhattan and the Bronx, Con Edison steps 138 kilovolt (kV) electricity down to 13.8kV. For historical/legacy reasons, Con Edison follows a slightly different standard in Brooklyn and Queens and yet a third standard on Staten Island. There is no universal standard for the different voltage levels. Other utilities in other places have still other standards for the different levels of substations, but the general order of magnitude for each analogous level is similar. For example, EDF Energy in London now transforms 132kV into 11kV at what it terms "primary" or "main" substations.

Basically, the area substation is the neighborhood-level distribution hub—and more and more New York neighborhoods need one of their own.

A 69kV/12kV transformer is labeled for visitors to the showcase Park Substation in Anaheim, California.

A room full of switchgear in the 132kV/11kV substation that lies beneath London's Leicester Square.

Figure 1. Power Path



Manhattan's Chelsea district has been popular enough that luxury apartment buildings have sprouted even around traditional, ugly enclosed substations.

What neighborhoods don't need is the typical exterior of New York substation tradition—an unattractive and alienating brick or concrete building surrounded by a chain-link fence and razor wire. Even worse, in less developed areas, is the unenclosed substation—electrical equipment completely naked to the elements. Fortunately, many other design solutions are possible.

But who would want to live near an open-air substation like this one in downtown Anaheim?

After electricity leaves the area substation at 13.8kV, the final step down to usable (120/208) voltage occurs in New York's street network—transformers under sidewalks in Manhattan and on utility poles throughout much of the rest of the city. (With the United Kingdom's very different end-user voltage, London's electricity is reduced from 11kV to 415V at "secondary" substations before its final cable distribution.)

The step before the area substation is the "transmission substation," where Con Edison transforms 345kV into 138kV.[2] These substations intermediate between high-tension transmission lines from outside the five boroughs and the city's electrical distribution system. A transmission substation generally feeds three to six area substations. Utilities try to site at least one of those area substations very near (ideally collocated with or adjacent to) the transmission substation. In principle, the zoning and urban-design solutions proposed in this paper are applicable to transmission substations as well as to area substations—transmission substations can be designed to fit into their host neighborhood, as Con Edison's new Mott Haven substation, in the Bronx, does.[3] But the most urgent task is to outfit neighborhoods with the friendly area substations they need to power homes and businesses.

THE ZONING CONUNDRUM: WHERE SUBSTATIONS ARE NOW, AND WHY

At present, New York City's Zoning Resolution (ZR) serves as an obstacle to building neighborhood substations. Electrical substations are allowed "as-of-right" on industrially (**M** or "manufacturing") zoned land; with few exceptions, siting them anywhere else means going through a difficult and time-consuming process to obtain discretionary approval from the city government. And, more and more, "anywhere else" in the city means the residential and commercial neighborhoods they need to serve.

The purpose of zoning is to regulate uses and density, and the ZR does so down to the lot level by means of a comprehensive set of maps keyed to twenty-one basic zoning designations and their many sub-designations (see sidebar, "Zoning Categories in New York's Zoning Resolution"). The ZR was adopted in 1961, and although its text and associated maps have been amended many times and in many ways over the intervening decades, its fundamental structure has been left unchanged for nearly fifty years. It does not account for how the world has evolved in the interim, especially technologically.

ZONING CATEGORIES IN NEW YORK'S ZONING RESOLUTION

There are three major categories[4] of zoning district in New York's Zoning Resolution.[5]

"Residential" (***R***) zones, accounting for approximately three-quarters of the city's zoned land area,[6] range from neighborhoods of single-family, detached houses (R1, R2) to dense high-rise areas (R10). Besides housing, the uses permitted as-of-right in ***R*** zones include "community facilities" such as health-care facilities, schools, libraries, and houses of worship.

"Commercial" (***C***) zones range from local retail and service districts (C1, C2) that serve adjacent residential neighborhoods to the high-rise central business districts of Midtown, lower Manhattan, and downtown Brooklyn (C5 and C6). There are also several districts dedicated to specialized businesses. For example, C8 allows automotive repair shops as well as common commercial uses, from hotels to local retail, along with community facilities.

"Manufacturing" (***M***) zones allow a range of manufacturing and industrial uses, basically increasing in noxiousness from M1 to M3. (For example, stockyards and sugar refining are permitted only in M3.) M1 allows a range of activity similar to C8's, but non-***R*** uses that are quasi-residential (hotels, dormitories) are banned from M2 and M3.

In addition to the zoning designations, the ZR features eighteen "use groups," listing in great detail the various purposes and activities for which buildings are designed and occupied and land employed. For every zoning designation, some use groups are permitted as-of-right, some by special dispensation, and others not at all.

Most electrical substations are assigned to Use Group 17. Broadly speaking, Group 17 includes the second-most noxious use collection of the eighteen groups. Along with substations of any size, Use Group 17 includes manufacturing facilities for aircraft, automobiles, electrical equipment, ink, and pharmaceuticals. A use is assigned to this group (as opposed to Group 18) on the basis of its capacity to control "objectionable influences" and thereby "limit their impact on adjacent residential areas." Group 17 uses also "normally generate a great deal of traffic, both pedestrian and freight."[7] They are as-of-right in all **M** districts but not in residential or commercial zones.

Very small substations, fitting on a site of no more than 10,000 square feet, are assigned to Use Group 6 and may be built as-of-right on most commercially zoned land in the city (as well as in all **M** zones). If these are to be constructed in a residential (***R***) zone, however, they must undergo a special approval process. Use Group 6 mostly comprises retail stores and service businesses serving local consumer needs, but its "public service establishment" subgroup ("D") includes these small electrical substations and all telephone exchanges (containing equipment for switching phone signals), along with courthouses, fire stations, and pumping facilities. Of all the 6D uses, only substations are subject to a limit on footprint size.[8]

For most area substations, a lot of 10,000–40,000 square feet is required.[9] To occupy a footprint of that size, Con Edison[10] must get a special permit from the Board of Standards and Appeals (BSA), an independent board that can grant "relief" from the zoning code. For an even larger substation to be built in a residential or commercial zone, the utility company needs the City Planning Commission (CPC) to issue a special permit.

The BSA and CPC special-permit processes are described in Figure 3 and Figure 4, respectively. The CPC process is more demanding, requiring full compliance with the city's Uniform Land Use Review Procedure (ULURP) before approval. But the BSA process is also a significant obstacle, not least because its requirements and timeline are less transparent than those of ULURP. Organized opposition to a proposed substation often grows during these multi-month or even multiyear approval processes. Delays add expense to the project—and pressure to construct the substation quickly, once it is approved, in order to maintain reliable distribution. It is not unheard of for the permit to be denied in the end. Small wonder that Con Edison prefers to build substations in **M** zones.

Figure 2. Substation and Utility Siting in New York's Zoning Resolution

	Residential Zones	Commercial Zones	Manufacturing Zones
Electric or gas utility substation, open or enclosed, on a site ≤ 10,000ft²	BSA special permit required (ZR 22-21, as amended September 2004)	Use as-of-right in C1, C2, C4, C5,* C6, C8 but never permitted in C6-1A (or C3 or C7) (Use Group 6D)	Use as-of-right (Use Group 6D)
Electric utility substation, open or enclosed, on a site 10,000–40,000ft²	BSA special permit required (ZR 22-21, as amended September 2004)	BSA special permit required (ZR 32-31, as amended March 2006)	Use as-of-right (Use Group 17C)
Public transit or railroad electric substation, open or enclosed, on a site ≤ 40,000ft²	BSA special permit required (ZR 22-21, as amended September 2004)	BSA special permit required (ZR 32-31, as amended March 2006)	Use as-of-right (Use Group 17C)
Public utility station for oil or gas metering or regulating	BSA special permit required (ZR 22-21, as amended September 2004)	Use as-of-right in C1, C2, C4, C5,* C6, C8 but never permitted in C6-1A (or C3 or C7) (Use Group 6D)	Use as-of-right (Use Group 6D)
Telephone exchanges	BSA special permit required (ZR 22-21, as amended September 2004)	Use as-of-right (with height limitations) in C1, C2, C4, C5, C6, C8 but never permitted in C6-1A (or C3 or C7) (Use Group 6D)	Use as-of-right (Use Group 6D)
Terminal facilities at river crossings for access to electric, gas, or steam lines	BSA special permit required (ZR 22-21, as amended September 2004)	Use as-of-right in C1, C2, C4, C5,* C6, C8 but never permitted in C6-1A (or C3 or C7) (Use Group 6D)	Use as-of-right (Use Group 6D)
Electric utility substations, open or enclosed, on a site 40,000ft²–10 acres	CPC special permit required (ZR 22-22, as amended October 1993)	CPC special permit required (ZR 32-32, as amended February 1998)	Use as-of-right (Use Group 17C)
Public transit or railroad electric substation, open or enclosed, on a site 40,000ft²–10 acres	CPC special permit required (ZR 22-22, as amended October 1993)	CPC special permit required (ZR 32-32, as amended February 1998)	Use as-of-right (Use Group 17C)
Public transit, railroad, or electric utility substation, open or enclosed, on a site > 10 acres	Never allowed	Never allowed	Use as-of-right (Use Group 17C)

* In C5, this use "shall not be located on the ground floor of a building unless such use is at least 50 feet from the street wall of the building in which it is located, as provided in Section 32-423 (Limitation on ground floor location)."

Source: CRD analysis of New York City Zoning Resolution

Figure 3. Obtaining a BSA Special Permit

City Charter Section 668 defines the procedure for obtaining a special permit from the Board of Standards and Appeals (BSA).

Within five days of the applicant filing for a BSA special permit, BSA forwards the application to the relevant community board (and borough board, if the site spans multiple community boards).

The community board has sixty days to take one of these possible actions:

- notify the public of the application
- hold a public hearing and, as a result, submit a written recommendation directly to BSA
- waive the public hearing and preparation of a written recommendation.

If two or more community boards are involved, they must forward their recommendations or waivers of recommendation to the borough board as well as to BSA. The borough board then has thirty days to hold its own public hearing and make recommendations pursuant to it or to waive its rights to take such action. All boards are required to copy the City Planning Commission on recommendations that they make to BSA.

BSA is authorized to review the application once it has received the written recommendation(s) or waiver(s), or once the sixty-day (or sixty-plus-thirty-day) period has elapsed without submission of recommendations or waivers by the relevant boards, whichever is sooner.

Any supplementary documentation submitted by the applicant to BSA following the sixty-day period (or, when necessary, the additional thirty-day period) must also be submitted to the City Planning Commission, the relevant council member(s), and to the community or borough board involved.

BSA is required to hold a public hearing before acting on an application. Its decision must include findings of fact, as required by the Zoning Resolution, and is subject to legal review.

Findings required for a special permit for a public service establishment (including a substation on a residential district site of no more than 10,000 square feet):

a. it will serve the residential area within which it is to be located and there are serious difficulties in locating it in a district where it is permitted as-of-right and from which it could serve the residential area; and
b. the site has a minimum lot area of 4,500 square feet.

Moreover, BSA may prescribe conditions to minimize adverse effects on the character of the surrounding area, including fencing, landscaping, and conforming with M1 performance standards.
[ZR 73-14, as amended July 1970]

Findings required for a special permit for a public transit, railroad, or electric utility substation on a residential or commercial district site of 10,000 to 40,000 square feet:

a. it will serve the residential area within which it is to be located (or the residential area immediately adjacent) and there are serious difficulties in locating it in a district where it is permitted as-of-right; and

b. in the case of a public transit or railroad substation, the site has a minimum frontage of 50 feet and a minimum lot area of 4,500 square feet; and
c. the site is located to minimize adverse affects on the integrity of existing and future development (and, if in a commercial district, to minimize the interruption of retail frontage); and
d. the architectural and landscaping treatment blends harmoniously with the area; and
e. it conforms with M1 performance standards.

Moreover, BSA may prescribe conditions to minimize adverse effects on the character of the surrounding area, including fencing, landscaping, and sound-proofing.
[ZR 73-16, as amended September 2007]

IT WASN'T ALWAYS THIS WAY

Thomas Edison's (and therefore New York's) original electrical distribution system used "direct current" (DC) rather than the "alternating current" (AC), which was later found to be more efficient at transmission and transformation and therefore widely adopted for distribution beginning in the early twentieth century. The DC system required substations to be very near utility customers. Thus, substations could be found in every neighborhood.

Even after the transition to AC for most users, railroads (including New York's subways) continued to operate "third rail" power on DC—as they do to this very day. The substations built for the Interborough Rapid Transit (IRT), Brooklyn-Manhattan Transit (BMT), and Independent (IND) subway systems were handsome examples of civic architecture, many with exteriors of the finest materials.[11] Transit substations require not only transformers but also equipment to convert power from the AC used for transmission to the DC required for the third rail, which electrifies the trains. Compact automatic rectifiers now perform the conversion, but originally the substations needed space for huge, manually operated rotary converters. Many of these substations predate the city's 1916 zoning resolution; all predate the current code (adopted in 1961), which lists them separately from utility substations but treats them the same.

Before 1916, utility and transit substations could be built anywhere in the city. After that, New York's first zoning code excluded new ones from residential districts but allowed them to be built in business districts as well as the "unrestricted" districts that prefigured the ***M*** districts of the 1961 zoning.[12]

As a result, the city is pockmarked with grandfathered substations—in residential (pre-1916) and commercial (pre-1961) areas. Only since 1961 have these public service facilities been forced to serve the public from afar.

Figure 4. Obtaining a CPC Special Permit

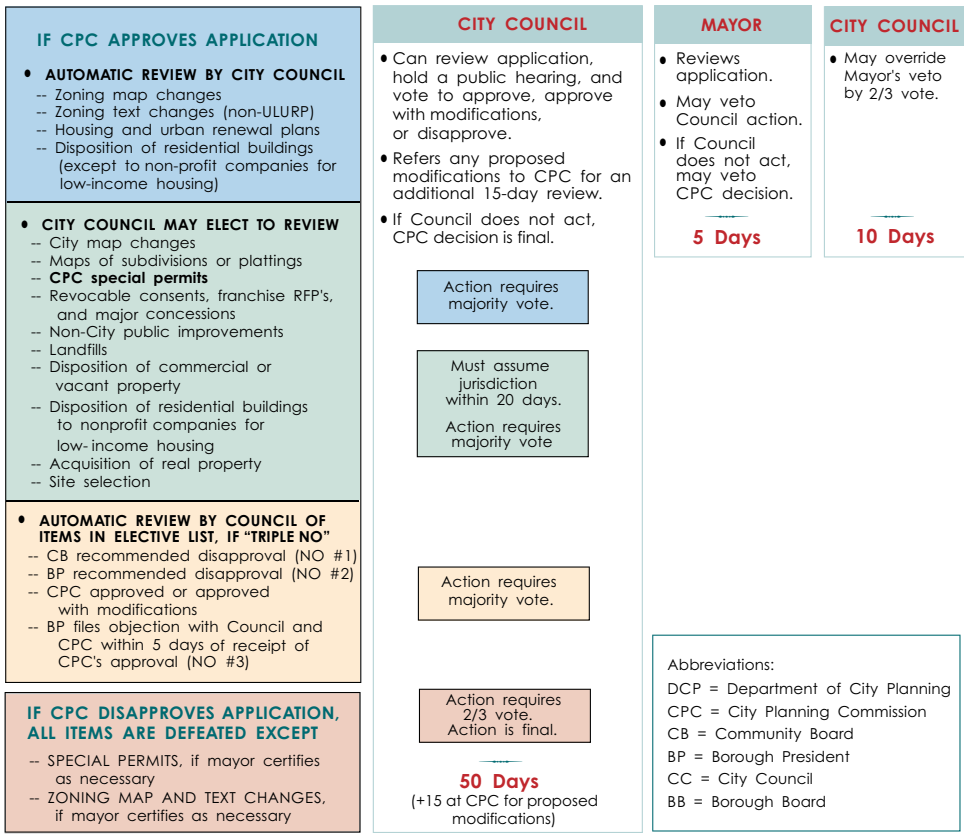
Section 197c of the City Charter requires that applications for special permits from the City Planning Commission (CPC) go through the Uniform Land Use Review Procedure (ULURP) to be approved. The steps involved in ULURP are detailed in City Charter Sections 197c and 197d. City Planning's graphical representation of those rules is available at http://nyc.gov/html/dcp/pdf/luproc/lur.pdf and adapted here.

DEPARTMENT OF CITY PLANNING Application and Pre-Certification	COMMUNITY BOARD	BOROUGH PRESIDENT (and BOROUGH BOARD)	CITY PLANNING COMMISSION
• Receives application and related documents. • Forwards application and documents within 5 days to Community Board, Borough President, and City Council (and Borough Board if project affects more than one CB). • Certifies application as complete.	• Notifies public. • Holds public hearing. • Submits recommendation to City Planning Commission, BP (and BB). • Can waive rights on franchise RFP's and leases.	• BP submits recommendation to CPC or waives right to do so. • BB (if project affects more than one CB) may hold a public hearing and submit recommendation to CPC or waive right to do so.	• Holds public hearing. • Approves, modifies, or disapproves application. • Files approvals, and approvals with modifications, with City Council.
No specified time limit (after 6 months, applicant or BP in some cases, may appeal to CPC for certification).	**60 Days**	**30 Days**	**60 Days**

Findings required for a special permit for a public transit, railroad, or electric utility substation on a residential or commercial district site of 40,000 square feet to 10 acres:

a. there are serious difficulties in locating it in a nearby district where it is permitted as-of-right; and
b. the site is located to minimize adverse effects on the integrity of existing and future development; and
c. the architectural and landscaping treatment blends harmoniously with the area; and
d. it conforms with M1 performance standards.

Moreover, CPC may prescribe conditions to minimize adverse effects on the character of the surrounding area, including fencing, landscaping, soundproofing, shielding artificial illumination, and surfacing access roads and driveways.
[ZR 74-61, as amended September 2007]



THE ZONING UPSHOT: WASTED LAND

Because it is difficult, time-consuming, and expensive to obtain a special permit for locating a substation on **R** or **C** land, Con Edison tries wherever possible to use **M** land. But there is a problem with **M** land: as New York has changed and grown, the amount of it has declined. The Bloomberg administration, recognizing that permissible uses of land had not been developing in step with the city's evolution from manufacturing center to service economy, has rezoned more than one-sixth of New York's landmass, much of it from industrial to some combination of residential and commercial. It will be harder and harder for Con Edison to find **M** land to buy as time goes on.

Which is why the utility holds on to the **M** land it already has and resists attempts to rezone neighborhoods where it owns such land. A spectacular example of this phenomenon is northern Manhattan's Sherman Creek neighborhood, where Con Edison is now constructing a new transmission substation next to acres of long-standing open-air facilities (see sidebar, "The Case of Sherman Creek").

If the zoning resolution allowed substations in commercial and residential districts as-of-right, Con Edison would have no reason to object to rezoning of **M** land. In fact, like other landowners, it could benefit from higher land values when its **M** land is reclassified. It would be free to site substations on the basis of engineering and not land-use realpolitik. And just imagine the possibilities if zoning and other considerations encouraged Con Edison to consolidate and stack facilities for efficient use of valuable land (see below, "Putting the *Sub* in *Substation*").

THE CASE OF SHERMAN CREEK

Con Edison is the Sherman Creek peninsula's largest landowner (followed by the city itself), controlling over three full city blocks and a significant segment of the water's edge. Bordered on the west by Inwood, which is bursting at the seams, and on the east by the dramatic Harlem River, the peninsula is underdeveloped, neglected, and polluted, even though its waterfront could be a stunning site for mixed-use development. For a couple of years in the middle of this decade, there was a major push, involving public planning workshops and significant community participation, to rezone and develop Sherman Creek. Now, two to three years later, the Department of City Planning's website classifies the effort as "inactive," even as Con Edison constructs a much-needed transmission substation alongside the Sherman Creek waterfront to supplement the open-air transmission-level and area-level substations already there.

The sprawling open-air holdings of Con Edison at Sherman Creek, as seen from the Bronx. Electrical equipment covers three huge tracts on the peninsula. The enclosed Academy Substation is under construction on a fourth.

Con Edison's East Yard blocks access to the Harlem River...

The new Academy Substation's siting results from capturing a moment of technological history in regulation. Academy is to sit on land once occupied by a power-generating station. In the old days, generating stations needed to be close to water. The unenclosed substations still in place were originally installed to be near the generating station. These and other industrial-type facts on the ground led to ***M*** zoning for Sherman Creek. Proximity to water is no longer necessary for power facilities, but the zoning and existing facilities serve to keep—or, in the case of Academy Substation, entice—them there, cutting off the waterfront from active, people-friendly uses. The new substation will be enclosed (and by materials more attractive than concrete and chain link), but the existing open-air facilities will continue to occupy acres of the peninsula, discouraging redevelopment of nearby properties, even if the zoning designation is changed to ***R*** or ***C***.

... which can be enjoyed from the small street-end park adjacent.

If Academy's lot had lost its ***M*** zoning, the utility would have needed a CPC special permit to put a substation on the 2.3-acre site. Generally a transmission substation can fit on a 80,000-square-foot site (i.e., less than two acres), but when Con Edison has space in hand, it tends to use it all rather than find ways to conserve it or combine uses. With its existing substations in place and with plans to build another on property it already owned, the utility resisted the Sherman Creek rezoning efforts. There was (and is) no incentive for Con Edison to undertake the difficult and expensive task of moving or concealing the extant equipment. As a result, the southern chunk of the Sherman Creek peninsula will remain unavailable for the foreseeable future.

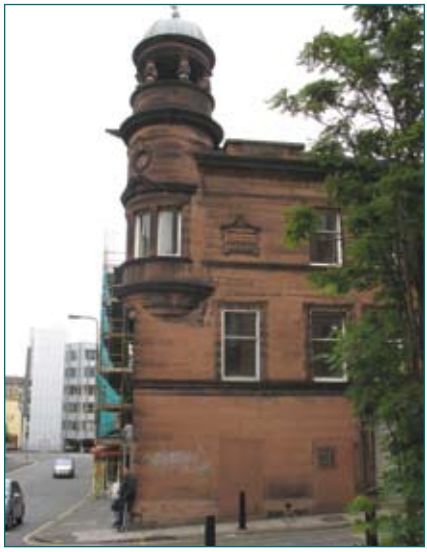
FITTING IN

The rear of this substation has provided one of the walls of London's Devonshire Square since the late 1970s. The substation's front yard is Jubilee Gardens, a landscaped seating area that camouflages the switchgear vents.

Breaking up the façade of Con Edison's Astor Substation with false windows helps it fit into its Manhattan mixed-use neighborhood.

Manhattan's West Side hosts a major stone edifice—and the substation designed to harmonize with it.

The one piece of good news in the case of Sherman Creek is that the new Academy Substation's façade will be designed and the grounds landscaped to blend with marinas to the peninsula's south.[13] Increasingly, Con Edison has been employing this approach—at Astor in Manhattan and Mott Haven in the Bronx, for example. The most common features are false windows and exteriors of brick and stone. One substation even was given a polished granite façade and monumental doors to respond to a major Manhattan landmark nearby. And there are plenty of examples of neighborly exteriors in other cities. London's Devonshire Square and Osaka's Dotonburi were both built decades ago. With



As part of a project to replace the obsolete equipment of its unenclosed substation downtown (see photo on page 4), Anaheim Public Utilities recently switched service over to this attractive new structure, designed to fit into its surroundings and echo the architecture of a nearby powerhouse building of yesteryear.

Without the help of the Osaka subway map identifying the red icon as Dotonburi Substation (top right), a visitor would be hard-pressed to find the facility amid the bustle of the Japanese city's fashionable Amemura district (top left). Kansei Electric Company allowed urban artists to paint the substation's brick exterior.

Edinburgh's modern financial center sprouted around the open-air Dewar Place Substation in recent years (middle left). ScottishPower is engaged in a major project to upgrade capacity and enclose Dewar Place's new equipment within the historic walls of a landmarked nineteenth-century power station (lower right). Gas-insulated transformers and switchgear provide the compactness necessary for this 275kV/33kV substation in the midst of Edinburgh's World Heritage Site downtown.

centrally located, unenclosed substations reaching the end of their useful lives in Anaheim, California, and Edinburgh, Scotland, Anaheim Public Utilities and ScottishPower, respectively, are constructing historically respectful structures to enclose the replacement equipment.

But an above-ground, stand-alone substation structure is far from the only answer for cities where land is especially precious.

PUTTING THE *SUB* IN *SUBSTATION*

The office floors of 7 World Trade Center sit atop Con Edison's Trade Center Substation, a major electrical distribution point for lower Manhattan. Changing zoning restrictions would enable New York to install more substations like this.

The laundromat that rents videos and mailboxes. The shoemaker and the locksmith who subdivide a 20-foot storefront. The five college grads rooming together. What's more New York than sharing space?

Substations can bunk with others, too. Let's put the "sub" back into "substation" by placing substations underneath buildings and parks and plazas, where they are out of public view and can't elbow aside more urbane uses of scarce land.

SUB BUILDINGS

The gleaming 7 World Trade Center (7WTC), opened in 2006, is a stunning example of just such an approach. An area substation forms its base, making the office space above it that much more valuable for starting at the equivalent of the eleventh floor rather than the second. In fact, the new 7WTC's predecessor and namesake, destroyed as a consequence of the attack of September 11, 2001,[14] also sat atop a substation. Con Edison's facility already occupied that site, so Silverstein Properties constructed the original 7WTC over it.

Tooley Street Main Substation and two distribution rooms are built into this parking garage, shoehorned between old and new construction on London's South Bank (right).

Kingsway Main Substation sits below the round office building and one of its distribution rooms in the base of the foreground office building. Another distribution room is across narrow Wild Street in residential Peabody Terrace. The City Lit Centre for Adult Learning's green banner is visible on the right.

Minami-Saya-cho Substation lies beneath the office tower at right, near Tokyo's Ginza. On line since 1997, the substation houses two 66kV/22kV transformers for distribution to major commercial customers, as well as two 66kV/6.6kV transformers for local distribution.

Disappointingly, Trade Center Substation is the sole case so far in New York of stacking unrelated uses above a substation. It is a very impressive case, of course: built to house ten transformers eventually (three are currently in place), the facility occupies a high-profile location and has as an exterior a piece of environmental art, with changing patterns of colored light that flash through its cladding of prismatic stainless-steel bars.[15] But just as a stand-alone substation doesn't have to be squat and windowless, a stacked substation doesn't have to be crowned by a gold-plated office tower. All that is needed is the right zoning and a big enough corner lot to permit easy installation and removal of equipment.

Land-starved cities such as London and Tokyo have been combining substations with other uses for decades. Kingsway Substation has rested beneath an office building in the heart of London's theater district since 1967. The new Tooley Street Substation, opened in 2002, anchors the city's up-and-coming Southwark neighborhood; both a main (132kV/11kV) and two distribution (11kV/415V) substations are built into the garage of a commercial complex abutting the Hilton Tower Bridge

Access to Sanban-cho Substation is under the gymnasium of a girls' high school in a more residential area of Tokyo. This 1995 facility features three 66kV/6.6kV transformers.

hotel. This past summer, demand for office space near Liverpool Station was so great that EDF Energy faced pressure to replace its 66kV/11kV open-air Finsbury Market Substation, dating to the 1940s, with a facility (ideally 132kV/11kV) that would be built beneath new office space constructed on the substation's present site. And no one is proposing to move a main substation now located in the basement of an EDF Energy district office after the district office is displaced by a new commercial building.

Similarly, all around Tokyo, many building types—from modern office towers near the Ginza to schools to traditional Buddhist temples—have housed transmission-level and area-level substations for decades. The Tokyo Electric Power Company (TEPCO) has scores of area-level "distribution" (66kV/6.6kV) and "intermediate" (66kV/22kV, to serve large customers) substations underground.

TEPCO placed a substation under a modern satellite to its headquarters that it constructed in central Tokyo—one of more than a dozen underground transmission-level "primary" (275kV/66kV) substations. Higashi-Uchisaiwai-cho Substation's gas-insulated transformers (GIT)[16] are installed five levels (nearly 100 feet) below street level and lie beneath three stories of underground parking, a below-ground retail level, and twenty-two above-ground floors. It extends below most of an entire square block on which sit the building's landscaped forecourt and driveway and a public plaza that is the site of open-air concerts.

The transmission-level (275kV/66kV) equipment at Higashi-Uchisaiwai-cho Substation is located mainly under TEPCO's own building (top) and forecourt in congested central Tokyo. Other facilities, including space to install an area-level substation in the future, lie beneath the adjacent public concert plaza (bottom).

The reconstructed remnant of Meijo (Nagoya Castle) towers over the substation complex from on high. On the left is a Noh theater. The substation's ventilation building (also containing the elevator for access to the public parking garage) is in the right foreground. Behind the stone-façade ventilation building is a small structure housing the elevator for secure access to the substation levels beneath the underground public parking garage. From this angle, the statue of castle architect Katô Kiyomasa blocks the view of the ventilation building's moat and footbridge.

Turning the roof of a substation into a public space is another alternative preferable to low-rise, stand-alone utility structures. Tokyo's Higashi-Uchisaiwai-cho Substation provides two such lovely, small-scale amenities in a congested area across a narrow street from the viaduct of the main Japan Rail line through Tokyo.

Japan's fourth-largest city, Nagoya, offers a much more dramatic example. Chubu Electric Company's Meijo Substation lies beneath a parking lot serving Nagoya's most famous landmark, the remains of Meijo, a castle built by Shogun Tokugawa Ieyasu in 1612. The parking lot today is smaller than it once was because in the early 1990s the city decided to build a Noh theater and a large landscaped plaza with public amenities on a portion of it, placing the lost parking spaces below ground. An area-level (154kV/33kV) substation already existed underneath city parkland on the far side of a street bordering the parking lot. In tandem with the city's redevelopment of the site, Chubu Electric constructed a new transmission-level (275kV/154kV) substation extending under the plaza, the parking garage, and the parking lot, where it could feed the area-level substation across the street, as well as others farther away. As with Tokyo's Higashi-Uchisaiwai-cho, Meijo Substation's transformers are located approximately a hundred feet below street level. One floor above them is the cable room, and one floor above that is the switch room. Above that is the underground parking garage.

Chubu Electric employs an unusual gas/fluid hybrid technology for cooling its transformers.[17] The equipment can be toured by local school groups and other interested parties and accordingly carries explanatory labels in Japanese and English. Theatergoers and castle visitors, however, have no way of knowing that huge electrical transformers lie below their feet. After taking an elevator from the underground parking garage, which sits beneath the substation's handsome and low-slung ventilation building, they cross a footbridge over a moat, across from which sits the theater. A large plaza surrounds the stone-faced ventilation building, several equally attractive ancillary structures, and the theater. High above loom the castle and its grounds. Because Meijo Substation is situated in a public park, within view of a unique historical and cultural landmark, Chubu Electric had to obtain special design approvals from the city. The result is distinguished architecture encasing a technological showplace.

The Meijo Substation is completely invisible from the castle, although the theater's roof can be spotted amid the trees.

"Nagoya people love waterfalls," said a Chubu Electric engineer as he pointed out the cooling and noise-camouflaging feature on the side of the Meijo Substation ventilation building that faces the castle (bottom). Another waterfall hides the subpark area-level (154kV/33kV) substation that preexisted the magnificent transmission-level (275kV/154kV) Meijo Substation across the street.

In London, too, reconstruction of a key public space provided a utility an opportunity to install a major new substation. In 1989, London Electricity (now EDF Energy) obtained planning consent from the Westminster City Council and a 999-year lease for land underneath Leicester Square, the hub of the city's West End, for a primary (132kV/11kV) substation to provide new capacity. The facility is so fully integrated into the park that the control panel for

Completely unaware of the substation beneath their feet, thousands flock to London's Leicester Square to spot Meryl Streep and Pierce Brosnan at the world premiere of *Mamma Mia* (left). A few days earlier, an EDF Energy worker opened the pavement to gain access to the facility (right).

POWER UNDER A NEW PARK?

In 2007, the Riverside South Planning Corporation (RSPC), a venture of seven civic organizations[18] instrumental in the planning and approval of Riverside South—a mixed-use development, including waterfront park, stretching from 59th Street to 72nd Street along the Hudson River and originally approved in 1992—assembled an expert planning panel to consider options in the public interest for the southernmost portion of the development. RSPC took this action following Extell Development Company's announcement of its intent to reopen Riverside South's approval agreements for the area from 59th to 61st Streets.

The panel recommended reorienting the park planned for this area and constructing "community utilities" beneath it. These public service uses could include: a rail station (serving MetroNorth Railroad's Hudson Line and/or the Amtrak Empire Connection that already operates on rail *in situ*); a tipping floor for solid-waste compaction; and a cogeneration plant to provide electricity, cooling, and heating for the new development of approximately 2,000 apartments. RSPC's panel further suggested that such a cogeneration plant be constructed with sufficient steam capacity to allow the retirement, landmarking, and adaptive reuse of Con Edison's underutilized steam plant, which occupies the full block bounded by 58th and 59th Streets and 11th and 12th Avenues.

RSPC's proposed cogeneration plant would be the first power facility under a New York park. But other types of infrastructure pave the way for this kind of land efficiency. The city's most glorious subway station has lain below City Hall Park since 1904, albeit closed to the public for far too long. A stupendous valve chamber built to manage New York's Third Water Tunnel sits 250 feet under Van Cortlandt Park in the Bronx. Elsewhere beneath Van Cortlandt, a water-filtration plant is now under construction, eventually to be topped off by a golf driving range. And New York State's Riverbank Park sits atop North River Wastewater Treatment plant on the Hudson from 137th to 145th Streets.

providing access to the substation by means of a hatch in the pavement is built into Leicester Square's signature discount-theater-ticket kiosk. The substation is completely invisible and inaudible to the hordes of park users above it. On a normal day, thousands of pedestrians stroll several feet above the substation's roof. When the Leicester Square Odeon hosts a film premiere, thousands more congregate above the transformers and switchgear, whose existence is unknown to them.

The United States is far behind Europe and Asia when it comes to burying substations beneath public parks. It was only two years ago that Anaheim Public Utilities opened this country's first such facility, in the California city's East Hills neighborhood. Park Substation is one of a dozen area-level "distribution" (69kV/12kV) substations; the distribution system is fed by two 230kV/69kV transmission-level substations. As a department of the City of Anaheim, the utility builds its facilities on city-owned land. Exempt from most local zoning rules, it solicits community input on design questions.

Anaheim Public Utilities took advantage of sloping topography to build the 69kV/12kV Park Substation into the side of this hill—topping it off with a manicured public lawn.

To build Park Substation, Anaheim Public Utilities cut into the side of a sloping lot in a hilly area of eastern Anaheim. Just to the west, immediately adjacent to the site, expensive single-family residences overlook Roosevelt Park, the well-maintained passive-recreation space atop the substation's roof. The sides sloping up from the street are terraced and planted. A garage door fitted into the north side of the hill is the sole indication of something going on beneath the quiet community park. Not just an unobtrusive neighbor, Park Substation turned out to be a benevolent one.

Anaheim boasts the first U.S. substation built under a park.

THE ZONING SOLUTION: THE NEIGHBORLY SUBSTATION

These examples from three continents demonstrate the variety of ways that a substation can be designed to fit into its particular context. It may have a façade that complements its surroundings—a response particularly suited to low-rise, urban neighborhoods. It could, whether from ground level or below, carry a commercial structure or community facility on its shoulders—an approach appropriate to districts of taller buildings. Or its roof could provide open space—an amenity sought by virtually every neighborhood in New York City. It is time to amend New York's zoning resolution to encourage these urban-design solutions, even in districts currently reserved for manufacturing.

Assuming that these areas are reclassified, Con Edison should build substations within them that are just as friendly as those that fit unnoticeably into established neighborhoods. Doing so would eliminate the risk that such infrastructure development would abort the natural evolution of these districts into places fit for habitation and commerce.

The most straightforward way to make this land available is to amend the zoning text, replacing the Use Group designation for substations of normal size (i.e., located on a site of up to 40,000 square feet)—now a "miscellaneous" (**C**) listing in Use Group 17—with either a new "miscellaneous" or a new "public service establishment" (**C**) category in Use Group 4.[19] (See Figure 5 for a summary of the changes proposed and Figure 6 for the text-change process.) A more cumbersome and somewhat less productive alternative would be to update Use Group 6D, the current home for public service establishments—including unusually small utility substations—so that unobtrusive substations of normal size could be built as-of-right in all manufacturing and most commercial zones.

According to the Zoning Resolution, Use Group 4 "consists primarily of community facilities which may appropriately be located in residential areas to provide recreational, religious, health, and other essential services for the residents" and "do not create significant objectionable influences in residential areas." It also includes "open uses" such as parks, playgrounds, and transit rights of way.[20] Electricity is certainly an essential service, and enclosed substations should not be the cause of protests (see below, "A Substation as My Neighbor?!").

To qualify as a Group 4 use, a substation would have to be underground or enclosed. If the latter, the structure must meet the bulk, height, and setback requirements of the zoning designation of the lot in question. In low-density zones (R1–R5), it makes perfect sense to build a low-rise substation.[21] But why do so in high-density

Figure 5. Neighborly Substation Zoning Proposal

	Residential Zones	Commercial Zones	Manufacturing Zones
Gas utility substation,[22] open or enclosed, on a site ≤ 10,000ft²	BSA special permit required (ZR 22-21, as amended September 2004)	Use as-of-right in C1, C2, C4, C5,* C6, C8, but never permitted in C6-1A (or C3 or C7)	Use as-of-right
Enclosed or underground public transit, railroad, or electric utility substation[23] on a site ≤ 40,000ft²	Use as-of-right in R1-R10 (i.e, all residential districts). A new category of public service establishments or miscellany should be created in Use Group 4 as Use Group 4C. (The existing 4C "Accessory Uses" would become 4D.)	Use as-of-right in C1-C6 and C8 (i.e. all commercial districts except C7).[24] A new category of public service establishments or miscellany should be created in Use Group 4 as Use Group 4C. (The existing 4C "Accessory Uses" would become 4D.)	Use as-of-right in M1. A new category of public service establishments or miscellany should be created in Use Group 4 as Use Group 4C. (The existing 4C "Accessory Uses" would become 4D.) BSA special permit in M2 and M3.[25]
Enclosed or underground electric utility, public transit, or railroad electric substation on a site 40,000ft² – 10 acres	BSA special permit required	BSA special permit required	BSA special permit required
Public transit, railroad, or electric utility substation, open or enclosed, on a site > 10 acres	Never allowed	Never allowed	BSA special permit required

* In C5, this use "shall not be located on the ground floor of a building unless such use is at least 50 feet from the street wall of the building in which it is located, as provided in Section 32-423 (Limitation on ground floor location)."

Source: CRD original proposal, based on existing structure of New York City Zoning Resolution

zones (e.g., C4-7, C5, C6-9), where a substation could be fitted either below or into the base of a quite tall building, which could then generate rents that more than offset the additional cost for Con Edison of acquiring and building on such valuable land? The zoning resolution should be explicit in allowing other uses above the substation. In addition, the zoning text regulating "location [of a particular function] within buildings" (ZR 32-42) and "ground floor use in certain locations" (ZR 32-43) would have to be amended.[26]

Purely for reasons of size—not function—unusually large substations (i.e., those located on sites of 40,000 square feet to 10 acres) should obtain a special permit not, as they have been, from the City Planning Commission but rather from the Board of Standards and Appeals. At present, BSA must make three "findings" before it awards a special permit for a substation on a site of up to 40,000 square feet. Such substations should be built as-of-right, with the permitting process reserved for facilities on sites exceeding 40,000 square feet. The three elements BSA must find are that:

- the site selected would minimize the facility's adverse impact on existing or future development and on continuity of retail frontage;
- the architecture and landscaping blend harmoniously with the rest of the area; and
- the use complies with defined "performance standards" for sound, vibration, etc.[27]

It would be especially easy to satisfy these findings with an underground substation.

Without a special approval process, there is no obvious way to impose design criteria on Use Group 4 stand-alone substations—although tossing "blend harmoniously" language into the use listing cannot hurt. One approach is to educate communities about the range of design solutions that they can demand from Con Edison. Another is to offer utilities a package of zoning changes beneficial to siting, provided that they agree to follow design guidelines.

Nothing in the zoning resolution precludes building a park on top of a substation. Indeed, parks are themselves covered by Use Group 4, so it should not be too much of a stretch to add some text encouraging the development of substations modeled on Leicester Square and Meijo.

Finally, to be neighborly, a substation must be enclosed or subterranean. It is difficult to imagine a new, unenclosed substation as appropriate anywhere in twenty-first-century New York, but this proposal allows for their construction on very large sites in **M** districts by BSA special permit.

Figure 6. Amending the Text of New York's Zoning Resolution

Section 200 of the City Charter defines the procedure by which the text of the Zoning Resolution may be amended.

The City Planning Commission (CPC) must notify any community board or borough board that may be affected by the amendment that it is considering adopting, and it must hold a public hearing on the proposed amendment. Proposals to amend the zoning text may be generated by CPC either on its own initiative or in response to an applicant.

Following adoption by CPC, the amendment must be reviewed and approved by the City Council (pursuant to City Charter Section 197-d; see right-hand page of diagram in Figure 4).

The text amendments recommended in this paper would apply throughout the city and therefore would need to be referred to all community boards and borough boards. Although amending the zoning text does not require hearings, reviews, or approvals by community boards or borough boards, City Planning generally approaches the text-amendment process as it does ULURP (see Figure 4) and expects the boards to respect the ULURP turnaround times. Any board resolutions adopted are purely advisory. Thus text amendments (such as those recommended in this paper) are adopted once approved by CPC and a majority vote of the City Council.

A SUBSTATION AS MY NEIGHBOR?!

Utility companies often encounter resistance when proposing a site for a new substation. Neighbors fear that the facility will bring increased risk of fire or explosion. Some have concerns about noise made by operating machinery or the long-term health effects of exposure to high voltage. They certainly worry about the disruption, dirt, and decibels of the construction period. But the biggest questions are about design: What will this substation look like, and what will it do to the visual and social fabric of the neighborhood?

At its most fundamental level, a substation houses high-voltage electrical equipment. Transformers and high-tension cables can be deadly—which is why the building encasing them has to be highly secure. The electrical equipment *inside* the facility is dangerous, but it cannot reach through the substation wall and electrocute a passerby.

In addition to its capacity to shock, high-voltage electrical equipment can indeed catch fire and even explode. A substation, however, has switchgear to break the circuit and interrupt the arc of electricity created and thus minimize the damage from a short circuit. Once again, these dangers are far greater in unenclosed substations. Burying the equipment or encasing it in a building contains the risk, and utilities including Con Edison have high civil engineering standards governing the strength of the structure. A buried or enclosed substation's real fire hazard is destruction of the equipment inside it, not immolation of its neighbors.

Each day, thousands of New York commuters stream past exposed 13.2kV transformers without a second glance.

High voltages are also associated with strong electromagnetic fields (EMF). In recent decades, several research studies have attributed disease to EMF exposure—most notably, childhood leukemia—but methodological questions cast doubt on the findings. In response to public concerns, the World Health Organization (WHO) established the International EMF Project in 1996 to assess the scientific evidence of the possible health effects of EMF. Based on a thorough review of thirty years of scientific literature, WHO recently concluded that "current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields."[28] The intensity of EMF decreases dramatically with distance from the voltage source; thus a strong field directly below a (naked) power line falls to a "normal" background level beyond 200 feet. Moreover, building walls interrupt the field, and metal shields it very effectively. So once again, simply burying or enclosing the substation mitigates any risk that may exist.

Transformers and their cooling equipment do emit a low buzz or hum. Often audible from an adjacent sidewalk, the sound is generally masked by ambient street noise. However, substations operate 24/7, so the noise can be a significant imposition on an adjacent residence or a business establishment during the quieter evening hours. Acoustical shielding is adequate to solve the problem. Anaheim Public Utilities installed noise-abatement materials at Park Substation, and Con Edison is using them to allay the concerns of neighbors of the new Astor Substation in Manhattan.

Although most concerns about the size and functioning of substations are groundless or easily addressed, New York City adheres to restrictions on their placement dating back half a century. In Japan, by contrast, substations are not excluded from any of the twelve district classifications used for city planning. And when Londoners raise objections to a new substation, they are actually objecting to the size of the development surrounding it, not to the substation itself.

There is no reason to relegate substations to a community's outskirts, since they can always be made as safe, quiet, and otherwise unobtrusive as any other kind of new development.

Facade of area-level substation at Mott Haven complex.

LAND AND POWER

People don't like ugly, scary substations near them. But substations don't have to be ugly and scary. And they do need to be nearby. The people of East Hills, Anaheim, chose a substation for a neighbor over a library—once they were told that they would also get a park on its roof. Thousands walk across Leicester Square each day, unfazed by the transformers beneath their feet. The presence of a substation downstairs does not dissuade tenants of 7 World Trade Center from paying top dollar for office space.

New York needs power, and it needs land. Changing the zoning rules governing electrical substations would help the city get more of both. By allowing electrical substations as-of-right in residential and commercial zones, the city would facilitate the most efficient system of distribution—as other cities have done, and as it did itself before 1961.[29] Freed of the delays and doubts posed by the land-use approval process, Con Edison could cut years from its facilities planning and the task of getting them on line.

In making available the most suitable properties for locating vital distribution hubs, the city would be removing Con Edison's incentive to hold on to industrial land. Land now locked in an **M** designation would be available for rezoning and site-appropriate development.

Encouraging Con Edison to stack other uses on top of substations is a way of making available even more land, which could be devoted to both commerce and recreation. The rents paid by an office building above a substation—and one with a higher than usual rentable first floor—should be able to offset over time any additional land-acquisition, engineering, and construction costs involved. If a utility builds a substation under a city-owned park or plaza, which it then rehabilitates (as utilities have done in Europe and Asia), it wouldn't have to incur the cost of acquiring land.

In the earliest days of electricity, substations operated in neighborhoods throughout the city without stirring protest. A century later, with an array of new technologies available, new ones can be better neighbors than ever, while delivering the power that the city needs to grow and thrive. It is time to get obsolete zoning regulations out of their way.

NOTES

[1] "PlaNYC for a Greener, Greater New York," City of New York, 2007, p. 114 (http://www.nyc.gov/html/planyc2030/downloads/pdf/report_energy.pdf).

[2] In London, the analogous grid supply point steps 275kV down to 132kV.

[3] The Mott Haven complex includes both a transmission (345kV/138kV) and an area (138kV/13.8kV) substation. It is one of the best-looking buildings in its neighborhood, an industrial area near the Bruckner Expressway. See Ken Belson, "To Keep Pace With Growing Demand, Con Ed Struggles to Build Substations," *New York Times*, August 5, 2008 (http://www.nytimes.com/2008/08/05/nyregion/05substation.html?_r=1&ref=nyregion&oref=slogin), for an anecdote illustrating the building's attractiveness.

[4] There are also a number of special-purpose districts with additional restrictions overlaid on a base of ***R***, ***C***, and/or ***M***. For example, the regulations of the City Island Special District are designed to preserve its nautical heritage and low-rise residential character; see http://home2.nyc.gov/html/dcp/html/city_island/cityisland1.shtml.

[5] "Zoning Resolution of the City of New York," Department of City Planning. See ZR Article II for residential, Article III for commercial, and Article IV for manufacturing regulations (http://nyc.gov/html/dcp/html/zone/zonetext.shtml).

[6] *Zoning Handbook*, Department of City Planning, New York, 2006, p. 6.

[7] ZR 42-14, as amended September 2004 (http://nyc.gov/html/dcp/pdf/zone/art04c02.pdf, p. 15).

[8] The only other 6D size limitation is on height for telephone exchanges—essentially to match surrounding commercial buildings. ZR 32-15, as amended September 2002 (http://nyc.gov/html/dcp/pdf/zone/art03c02.pdf, pp. 12–13).

[9] In most cases, it is possible to accommodate a transmission substation on an 80,000-square-foot lot. By definition, there are far fewer transmission than area substations, and thus less need to loosen zoning regulations to ease their siting. However, as noted on p. 4, the same principles of siting and urban design apply to these facilities. Setting the threshold for special approval at 80,000 square feet would enable this infrastructure to be located as-of-right as well.

[10] The same rules apply for public transit or railroad electrical substations (where the applicant would be the Metropolitan Transportation Authority or other public or private rail company) as for electric utility substations, where the applicant is Con Edison, but the main concern of this paper is utility delivery of power to homes and businesses. See Figure 2, "Substation and Utility Siting in New York's Zoning Resolution."

[11] See Christopher Payne, *New York's Forgotten Substations: The Power Behind the Subway* (New York: Princeton Architectural Press, 2002), for remarkable

images of the buildings and equipment, including a 1903 photo of construction amid Manhattan brownstones on East 19th Street (p. 37) reproduced as the backdrop for this sidebar. Clearly, there was an expectation in the early days that substations would be designed to fit into the neighborhood.

[12] Commission on Building Districts and Restrictions, *Final Report*, Board of Estimate and Apportionment—Committee on the City Plan, New York, 1916, pp. 233–36 (digitally imaged from a copy at the library of Harvard University's School of Landscape Architecture and available at http://books.google.com/books?id=Hd4AAAAAYAAJ&pg=PA15-IA2&lpg=PA15-IA2&dq=1916+use+districts&source=bl&ots=pl4e8xh9lo&sig=MxSOsSjn1YwlX-61re3AXhHzhw4#PPP1,M1).

[13] "Article VII Application to the New York State Public Service Commission for the M29 Transmission Line Project," Consolidated Edison Company of New York, Inc., 2006 (http://www.coned.com/PublicIssues/M29.asp#ArticleVII).

[14] There is no evidence that the substation's presence contributed to the fires that caused the collapse of the original 7WTC on September 11. "Questions and Answers about the NIST WTC 7 Investigation," National Institute of Standards and Technology, updated August 2008 (http://www.nist.gov/public_affairs/factsheet/wtc_qa_082108.html).

[15] David W. Dunlap, "A New Source of Power Rises Over Ground Zero," *New York Times*, May 4, 2004 (http://query.nytimes.com/gst/fullpage.html?res=9B06E1DB143EF936A15756C0A9629C8B63&scp=5&sq=Dunlap%20WTC%20substation&st=cse).

[16] Japanese utilities frequently use sulfur hexafluoride (SF6) gas as the insulator for both switchgear (GIS) and transformers (GIT) when compactness is a high priority for a substation. GIT has not made much headway among European and American utilities, which almost universally use oil to cool large transformers and cite cost and environmental concerns as reasons for not adopting SF6-insulated transformers. (ScottishPower is now installing Europe's first-ever SF6-insulated transformers at Edinburgh's Dewar Place Substation.) GIS is much more widely employed. New York's Con Edison has some GIS substations, but no GIT.

[17] A combination of sulfur hexafluoride (SF6) gas and perfluorocarbon (PFC) fluid.

[18] Municipal Art Society, Natural Resources Defense Council, New York League of Conservation Voters, New Yorkers for Parks, Regional Plan Association, Riverside Park Fund, and Westpride.

[19] The existing 4C ("Accessory Uses") would become 4D.

[20] ZR 22-14, as amended September 2004 (http://nyc.gov/html/dcp/pdf/zone/art02c02.pdf, pp. 7–9).

[21] For the purposes of BSA special permits, utility and public service establishments in R3, R4, and R5 districts are currently subject to R2 regulations for height and setback (ZR 73-11, as amended April 1994,

http://nyc.gov/html/dcp/pdf/zone/art07c03.pdf, p. 6). Given the densities involved, this requirement is reasonable and need not be changed.

[22] As gas utility substations fall outside the scope of this paper, the zoning rules for them are left unchanged.

[23] The concern of this paper is utility delivery of power to homes and businesses, but the same logic applies, and the same rules have applied and should apply, for transit and railroad substations as for utility substations.

[24] C7 is a very specialized zoning designation, currently in effect in only two locations in the city: the historic core of Brooklyn's Coney Island amusement area (which is likely to be rezoned in the next few years); and one block of the Bronx's Co-op City, the site of the short-lived Freedomland amusement park. There is no functional reason to prevent substations from being built as-of-right in C7 districts, but it is not worth carving out a special piece of Use Group 4 to deal with such rare situations.

[25] There is no functional reason to prevent substations from being built as-of-right in M2 and M3 (indeed, they are currently as-of-right in those districts), but it is not worth carving out a special piece of Use Group 4 to facilitate such situations. The BSA special permit for M2 and M3 substations only is the least burdensome approach overall.

[26] See http://nyc.gov/html/dcp/pdf/zone/art03c02.pdf, pp. 38–42.

[27] ZR 73-16, as amended September 2007 (http://nyc.gov/html/dcp/pdf/zone/art07c03.pdf, p. 11).

[28] "Electromagnetic Fields," World Health Organization (http://www.who.int/peh-emf/about/WhatisEMF/en/index1.html).

[29] Substations were built without special zoning approval in commercial districts until the 1961 zoning resolution.

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