Cost Savings and Energy Reduction: Bi-Level Lighting Retrofits in Multifamily Buildings

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ABSTRACT

Community Environmental Center implements Bi-Level Lighting fixtures as a component of cost-effective multifamily retrofits. These systems achieve substantial energy savings by automatically reducing lighting levels when common areas are unoccupied. Because there is a lack of empirical evidence documenting the performance of these systems, this paper uses electric consumption data collected from buildings before and after retrofits were performed, and analyzes the cost and consumption savings achieved through installation of Bi-Level Lighting systems. The results of this report demonstrate that common areas that are currently not making use of Bi-Level lighting systems would achieve significant financial and environmental benefits from Bi-Level focused retrofits. This project concludes that building codes should be updated to reflect improvements in Bi-Level Lighting technologies, and that government-sponsored energy efficiency programs should explicitly encourage or mandate Bi-Level Lighting installation components of subsidized retrofit projects.

INTRODUCTION

This paper seeks to answer the following question: "How can Community Environmental Center most effectively encourage the adoption of bi-level lighting systems in common areas of NYC's multifamily building stock?"

As the largest not-for-profit energy services firm in New York State, Community Environmental Center (CEC) has extensive experience with the installation of cost-effective and environmentally responsible 'retrofits' of NYC's low-income multifamily buildings. Through the implementation of government-sponsored programs such as the federal Weatherization Assistance Program (WAP), the New York State Energy Research and Development Authority's (NYSERDA) Multifamily Performance Program (MPP), and Mayor's Office of Sustainability Cool Roofs Program – CEC has developed a reputation as a sophisticated energy services firm, with a commitment to reducing the carbon impact of our shared built environment. CEC's Technical Services department has singled out 'bi-level lighting' as a particular retrofit measure that is under-utilized in common areas of multifamily buildings, and has commissioned this report to provide technical evidence as to the efficiency of bi-level systems and explore policy avenues for the encouragement of its further adoption by building owners.

This report will use the term 'bi-level lighting' to describe any common area lighting system in a multifamily building that automatically increases the illumination of installed fixtures when motion is detected. Historically, the most conventional use of bi-level lighting has been for exterior security systems of both commercial and residential buildings. These systems work by using ultrasound sensors to respond to the presence of motion, and illuminate the previously darkened area. Although the initial purpose of this technology was to provide occupancy-responsive security lighting – it became quickly apparent that significant energy savings were being achieved vis a vis exterior lighting systems that were illuminated throughout the night. The conventional assumption that it would be cheaper to leave security lights on all night than to replace the system with occupancy sensors began to be shown wrong.

Throughout the 1990s commercial businesses and multifamily residential managers began to explore bi-level lighting as a cost-effective alternative to 24-hour illumination strategies.[i] Particularly in California, building codes have encouraged adoption of this environmentally responsible measure. In 2001 Lamar Lighting Corporation developed the most common bi-level lighting systems installed today.[ii] These technologies were developed in response to a

solicitation by the New York State Energy Research and Development Authority (NYSERDA) and have been generally successful where implemented. CEC spearheaded one of the first substantial bi-level based retrofits in the Starrett City housing complex in East Brooklyn (also at the behest of NYSERDA), representing the first significant introduction of bi-level lighting technologies as an indoor energy-saving measure in New York.[1] Since this initial retrofit, CEC has installed bi-level systems as a common measure in low-income multifamily buildings throughout the New York City metropolitan area.

This report will assess the current state of bi-level lighting technologies, particularly with regards to usage in common-areas of low-income multifamily buildings in New York City. I will show that institutional attempts to require bi-level lighting through building codes are unable to proceed due to a lack of technical evidence of cost-effectiveness and a resistance from real-estate and public safety stakeholders. I will then provide a summary of evidence from a range of bi-level focused California retrofits, in addition to the results of a technical survey performed based on retrofit data from retrofits performed by CEC. Lastly, different policy avenues for the encouragement of bi-level lighting retrofits will be discussed, with a view toward determining the most effective, feasible and expedient route to transforming the bi-level lighting market in anticipation of eventual code-changes.

JUSTIFICATION

Fully 11% of the energy consumed in New York City is expended on lighting large buildings, contributing greatly to the carbon footprint of the city.[iii] Because bi-level lighting systems consume substantially lower amounts of electricity when spaces are unoccupied, they represent an environmentally friendly and cost-effective lighting strategy for building owners. Unfortunately, because widespread manufacture of bi-level systems has only recently become feasible, building stakeholders are generally unaware of the opportunities associated with bi-level lighting installations and retrofits. Additionally, in new construction projects, technical specifiers are hesitant to recommend bi-level systems due to a perceived code-ambiguity that assumes 24-hour single-level lighting.[iv] Although there are ongoing efforts to revise building-codes to encourage bi-level lighting, there is a perceived lack of technical evidence necessary to justify a mandate of these systems.

Because bi-level systems provide substantial energy savings wherever they are employed, retrofits are often cost-effective to the extent that associated costs are repaid – through lowered electricity bills – in less than ten years.[v] Where lighting systems are being initially installed or retrofitted anyway, the marginal costs of a bi-level system compared to a conventional system are minimal and payback is substantially shorter. Although it seems that installation of bi-level lighting should be an obvious decision for any multifamily building manager, many real estate stakeholders are unaware of the cost-saving potentials of building-system retrofits.

As an implementer of many low-income retrofit programs, CEC is well aware of institutional programs that can be harnessed to support highly efficient and recently developed retrofit technologies such as bi-level lighting. Institutional stakeholders that administer multifamily retrofit programs (such as NYSERDA, NYSDHCR, Community Based Organizations et al) should be aware of the environmental and economic benefits of bi-level lighting systems, and take concrete steps to encourage their installation wherever retrofits are performed.

In order to address the demonstrated need for further technical studies to be performed and compiled, this report will make the economic case for bi-level lighting systems, in the hope of contributing to the institutional processes that incorporate efficient technologies into building codes as technologies progress. Additionally, a coherent advocacy plan demonstrating policy avenues for the encouragement of bi-level lighting will be developed with a focus on large administrators of multifamily retrofit programs. As Community Environmental Center continues to pursue high-efficiency retrofits involving bi-level lighting, a further emphasis should be placed on documenting and publicizing the efficiency gains associated with bi-level lighting and other technically superior retrofit technologies.

CONTEXT

[1] CEC published a report based on the experience at Starrett City – although specific to the particular circumstances of the building, this report was valuable in setting the stage for further research.

In order to provide context for the encouragement of bi-level lighting technologies in multi-family common areas, this section of the report will detail actions undertaken by New York City's administration to improve lighting requirements, and contrast these developments with California's 'Title 24' building code revisions and other developments. The contrasting experiences with buildings codes will be particularly illuminating as a reflection of a wider range of stakeholders' perspectives on the technology and its importance. This section is based on interviews conducted by teleconference with members of the code committees of both states. This comparison will show that although California is substantially ahead of New York in employing bi-level lighting technologies, there is a shared need for further evidence of cost-effectiveness.

In July of 2008, Mayor Michael Bloomberg took the first significant step in 'greening' New York City's building code by soliciting Urban Green of the U.S. Green Building Council to draft a comprehensive set of recommendations for mitigating the environmental impact of NYC buildings. After establishing working groups of various technical experts to suggest improvements, on February 1st of 2010 the final draft of the code recommendations was released.[vi] Among more than 100 other code proposals,[2] recommendation EE7 advises the explicit permission of bi-level systems for multifamily buildings – resolving the ongoing ambiguity in the existing code that has contributed to the hesitancy of contractors to incorporate this cost-effective technology.[vii]

Another factor that has limited the acceptance of bi-level lighting systems is that firefighters have been historically opposed to any code changes that would decrease lighting requirements.[viii] Recently however, this objection has been reversed due to the fact that multiple lighting circuits involved in bi-level lighting fixtures defray the risk of systems failing in the event of a building-catastrophe.[3] With relevant stakeholders in favor of code revision, it is clear that the code will be revised to favor bi-level systems. Richard Leigh, the chair of the Energy and Ventilation Committee responded in interview saying "…we didn't spend a lot of time justifying bi-level lighting [because] everyone on the lighting committee knows it's a good idea."[ix]

The specific amendment states [bracketed text indicates changed or new language]:

> **(2) In every multiple dwelling hereafter erected, in addition to other lighting requirements, a sufficient number of [incandescent or fluorescent] electrical lighting fixtures shall be provided so that the distance between fixtures is not more than thirty feet and so that no wall is more than fifteen feet distant from a fixture.**
> **[(3) Automatic, occupant sensor lighting controls shall be permitted provided that the switch controllers are equipped for fail-safe operation ensuring that if the sensor or control fail the lighting levels will be at the levels required when the space is occupied, the illumination times are set for a minimum 15-minute duration, and the occupant sensor is activated by any occupant movement in the area served by the lighting units][x]**

Although it was initially expected that these codes would be signed into law in 2010, the Mayor has expended a significant amount of political capital on passing through other components of the Greener

[2] These proposed code changes make the telling recommendation of explicitly including pursuit of environmental goals as a central mandate of the building-codes.

[3] The two terrorist attacks on the World Trade Center provide an interesting case-study for bi-level lighting as a safety measure. In 1993, the bombing flooded the central lighting systems and building evacuation was harrowing and time-consuming. In contrast, during the 2001 attacks, improved lighting systems that incorporated bi-level technologies with battery packs facilitated the expedient evacuation of victims below the impact.

Greater Buildings Plan (GGBP) discussed below.[xi] Urban Green has now been advised by the City Council to significantly narrow the range of recommendations to be implemented (from 111 to less than 40) and it is not yet clear when the hearings will commence. Fortunately, in discussion with Bill Warren (an expert in the lighting field who contributed to the Urban Green task force recommendations and previous versions of lighting codes), it is expected that the bi-level amendment will definitely be included in whatever final pared-down code revisions are passed. For the coming round of code revisions, it will be a significant step to explicitly allow bi-level systems. Once the empirical evidence for the superiority of bi-level systems is widely acknowledged, it can be expected that explicit bi-level mandates will eventually be introduced.

In California, the prospects for mandated bi-level systems are substantially brighter. Statewide California lighting codes have expressly allowed for bi-level systems since the technology has been available, and code requirements explicitly outline the most efficient types of bi-level lighting systems to be installed.[xii] Californian energy codes have historically kept abreast of technological improvements by mandating any efficiency technology that fulfills the following three requirements: significant decrease in energy consumption; wide availability of the technology; and cost-effectiveness of the technology's installation.[xiii] The California Lighting Technology Center at the University of California, Davis (CLTC) has been performing technical studies on lighting systems since its foundation in 2003; alongside research solicited by the California Energy Commission through the Public Interest Energy Research (PIER) project, California stakeholders ensure that building codes reflect the current state of technical opportunities.[xiv]

Konstantinos Papamichael, the Co-Director of CLTC and advisor to the California Codes Committee, has stated that current efforts regarding bi-level lighting technologies are focused on outdoor and garage-based lighting systems. He expects parking lots and garage lighting will be mandated to provide lowered levels of illumination, when surroundings are unoccupied, once the 2011 energy code has been implemented. CLTC is currently performing initial case-studies of interior bi-level lighting systems in University of California dormitories throughout the state (results detailed below); creating an informational foundation that will provide evidence in support of mandated bi-level lighting systems later in the decade. Despite a perception in New York that "California is 10 years ahead" with regards to lighting technology, it is clear that they face similar issues in passing progressive building code requirements. In both states, it will be necessary for additional bi-level lighting surveys to be performed in multifamily buildings in order to gain wider acceptance among real estate stakeholders.

In speaking with code advisors in both New York and California, there was a genuine sense of optimism regarding the prospects of bi-level lighting. Where bi-level lighting systems have been implemented, authorities have been quick to embrace the improved lighting and efficiency.[4] The experiences of California and New York with regards to bi-level lighting codes show that although there is a perceived lack of technical evidence and institutional momentum, these systems are on their way to becoming a feature in multifamily buildings across the country. As Bill Warren stated: "Multilevel, Bi-level, it's all coming – we just haven't had the tools."

LITERATURE REVIEW

Although the underlying technology for bi-level lighting has existed for decades, in New York bi-level systems have only been commonly used for outdoor security-based motion detectors. It has only been in the last ten years that bi-level lighting has been adapted for indoor, common-area energy efficiency strategies. Because bi-level lighting systems are a relatively recent innovation in the energy efficiency sector, there is a dearth of empirical evidence measuring the specific savings-opportunities associated with lighting retrofits based on this technology.

This literature review will first discuss the existing technical literature and reports on bi-level lighting that have been performed to date. These limited studies will provide context for the technical

[4] California police were initially against bi-level systems in parking lots due to safety concerns. They performed "a complete 180" when the systems were actually installed, alerting police whenever someone was in the parking lot!

portion of this report and determine what sort of study could add the most value to the existing literature. Secondly the lit review will examine possible policy avenues for the further encouragement of bi-level systems through NYC energy efficiency stakeholders. This component will identify ongoing environmental strategies in NYC, and discuss California's adoption of a 'green code' that encourages bi-level strategies in multifamily common-area lighting systems.

Technical Literature

Despite the lack of comprehensive bi-level lighting studies, there have been a handful of reports detailing the effectiveness of individual retrofits that include bi-level lighting systems. These reports are valuable insofar as they provide anecdotal evidence as to the cost-effectiveness of bi-level based retrofits, but the specific characteristics of each retrofit cannot be meaningfully aggregated to the type of broad, empirical evidence required to convince real-estate stakeholders that bi-level lighting should be mandated.

In the multifamily housing complex Starrett City, Community Environmental Center received a research grant from the New York Energy Research and Development Authority (NYSERDA) to study the specific savings achieved through bi-level lighting. As the first major bi-level lighting focused retrofit, the resulting report states that a Savings to Investment Ratio (SIR) of 1.46 could be easily achieved in this complex, with the full costs of retrofits repaid through energy savings in only 3.43 years.[xv] Although these results show a great success for bi-level lighting in this particular building, it is important to note that Starrett City has extensive electricity generators, and the savings achieved through the retrofit do not necessarily reflect saving-potentials for a wide range of buildings. Additionally, NYSERDA sponsored bi-level lighting retrofits in two building in NYC, a multifamily housing complex on Roosevelt Island and a large commercial building on Lexington Avenue, both achieving payback in roughly 2.5 years.[xvi]

Similarly, CLTC and other stakeholders' installations of bi-level systems in dormitories and multifamily buildings throughout California provide valuable anecdotal evidence as to the efficiency of bi-level lighting systems. Unfortunately, because bi-level studies are generally performed on single buildings as individual research projects, there is a hesitancy to assume the results will be widely applicable. In order to overcome this obstacle, I propose that a 'meta-analysis' strategy be employed to assess the economic benefits of bi-level retrofits. In meta-analyses (pioneered by the statistician Karl Pearson in the early 20th century), results from wide ranges of individualized studies with similar hypotheses are aggregated to provide larger sample sizes and strengthen the results for an overarching study. Although the number of bi-level studies available for aggregation is insufficient to achieve statistical significance, by performing a quantitative meta-analysis on Californian studies I will provide groundwork for later studies that could meaningfully incorporate dispersed technical results into a coherent analytical structure.

Consultation with Da-Wei Huang of the Association for Energy Affordability NYC (AEA)[5] and other retrofit stakeholders has further emphasized the dearth of technical bi-level studies in New York.[xvii] Although firms with experience in bi-level lighting are unanimous in their support of this technology, and individual building-retrofits show cost-effectiveness, there are too many real estate stakeholders and retrofit firms that are inexperienced in procuring/installing bi-level lighting systems. Similarly, institutional stakeholders are lackluster in their support of specific retrofit measures without comprehensive evidence of cost-effectiveness. Firms that perform retrofits only receive funds for the direct installation of efficiency measures and there is a lack of resources for studying the impacts of specific retrofit measures.

In order to supplement the available resources regarding bi-level lighting cost-effectiveness, this report will provide 2 overarching studies of multifamily building lighting-retrofits: one meta-analysis reviewing bi-level installations by California retrofitters; and one based on energy consumption data of multifamily buildings retrofitted by Community Environmental Center. Hopefully this will provide a meaningful contribution to the technical literature that will justify the adoption of bi-

[5] AEA acts as a technical consultant to a wide range of energy efficiency implementers sponsored through the Weatherization Assistance Program, who do not have the capacity to perform sophisticated multifamily audits.

level strategies on a wider scale.

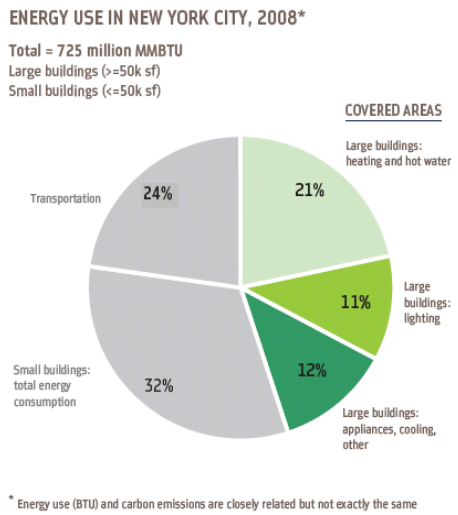
Policy Literature

The policy-related literature surveyed for this report includes two distinct components: reports and strategies associated with NYC's efforts to 'green' multifamily buildings through code revisions, and the existence of energy efficiency programs that could be utilized to encourage lighting-retrofits in low-income buildings. These components will respectively inform the status quo of bi-level lighting systems in New York and the 'best practices' associated with code-mandated bi-level installation.

New York City has ambitious targets for reducing its carbon emissions over the medium-term. Mayor Bloomberg has been a strong proponent of PlaNYC, which seeks to reduce carbon emissions in NYC by 30% before 2030. Since lighting systems in large buildings account for 11% of all NYC energy consumption, including transportation, (see Figure 1) [xviii] a significant amount of effort has been put into improving the efficiency of these systems. Through recently passed 'Greener Greater Buildings' legislation, all buildings larger than 50,000 sqft will need to replace inefficient lighting systems with Compact Fluorescent Lighting (CFL) before 2025.[xix] Unfortunately however, no explicit references to bi-level lighting exist in the legislation or policy guidelines for these mandated retrofits, nor are specific strategies outlined to address lighting inefficiencies in smaller multifamily buildings.

Another portion of PlaNYC and the Greener Greater Buildings strategy includes a 'green' revision of the currently applicable building codes in NYC.

Figure 1:



Mayor Bloomberg and Council Leader Quinn requested the Urban Green Codes Taskforce to propose comprehensive revisions to the existing code. Recommended measure EE7 deals with the current ambiguity of lighting codes, which are based on outdated measures of efficiency and luminescence. Although this recommendation would explicitly allow the installation of bi-level systems in multifamily common-areas, there is no consideration of possible mandates for installation of the cost-effective and highly efficient technology.

In addition to NYC's efforts to increase lighting efficiency, federal and state programs (such as the Weatherization Assistance Program and the Multifamily Performance Program) provide an opportunity for reducing the impact of buildings on the environment. Both of these programs offer different tiers of specific retrofit-measure encouragement. Currently in both programs bi-level lighting systems are generally allowed as a retrofit measure, but could be further encouraged through adoption of material standards for bi-level fixtures, and direct engagement with contractors to encourage adoption of bi-level systems.

Ultimately, a survey of pertinent technical literature shows us that there is a distinct need for overarching studies showing empirical evidence of efficiency gains made possible from bi-level retrofits. A survey of policy-related literature and reports show that NYC stands poised to adopt more stringent requirements for lighting efficiency. Similarly, California provides a valuable case study for governments hoping to encourage adoption of most-efficient lighting technologies.

METHODOLOGY

The technical component of this report will be two-fold. Firstly I will discuss the quantitative results from a post-retrofit survey of a selection of NYC multifamily buildings that received bi-level lighting installations from CEC; and secondly I will perform a 'meta-analysis' (as discussed above) of various other small-scale studies performed in California. In both of these studies I will be assessing the Savings to Investment Ratio (SIR)[6], a common measure of cost-

[6] Savings to Investment Ratio - SIR is determined by comparing the energy savings that will accrue over the lifecycle of the measure with the initial total costs of retrofit materials and installation (including a

effectiveness used by DOE in determining WAP eligibility, and the number of years it takes for energy savings to totally repay installation and procurement costs (referred to as payback). By providing empirical results of cost-effectiveness in a format consistent with programmatic guidelines, as well as in the format most practical to building stakeholders, the results of these surveys will contribute to the overall perception that bi-level lighting is a valuable retrofit investment for multifamily common-area buildings.

In performing the post-retrofit survey, I initially identified a range of approximately 50 buildings that received bi-level lighting retrofits from CEC between 1999 and 2005. These buildings were selected based on the availability of technical energy audit reports in CEC's hard-copy archive. In these initial reports I was able to extract the following data for each building: baseline energy consumption as determined by a year of energy bills; cost of overall retrofit determined by technical audit; the distinct costs of fuel vs. electric retrofit measures; cost of common-area lighting upgrade (the bi-level component); and the proportion of expected savings that would result from the common-area lighting upgrade. Although it was initially hoped that this selection of buildings would prove sufficient to perform a statistically significant analysis of bi-level lighting retrofits, an unexpected hiccup arose in building owners' reticence to provide CEC with post-retrofit energy bills – severely limiting the number of buildings included in the final survey. Fortunately, with the help of staff at the West Side Housing Federation and Grenadier Realty Corp,[xx] I was able to identify post-retrofit electric consumption data for 12 large multifamily buildings.[7]

In order to parse out the electric savings specific to the common-area lighting upgrade, I multiplied the overall kWh electric savings by the percentage of savings initially expected to result from the common-area component, and converted savings to dollars based on previous years' electric rates. With this estimate of the savings achieved by bi-level lighting in these specific retrofits, I was able to use the initial costs of the materials and labor to determine a savings to investment ratio, and a rough approximation of the 'payback' timeframe of a bi-level upgrade. A significant limitation of this analysis was a lack of direct monitoring of bi-level energy consumption in retrofitted buildings. This analysis should be seen primarily as an estimate of the cost-effectiveness; the appropriateness of bi-level lighting for any individual retrofit should be based on the specific energy audit results of a multifamily building. The results of this quantitative analysis are discussed below.

The meta-analysis of California retrofits was performed by initially collecting a range of small-scale studies performed by the CLTC and PIER programs. In identifying appropriate studies, I searched for commonly reported statistics, in order to form the foundation for the meta-analysis. I was able to identify 14 separate small-scale studies of bi-level retrofits in dormitories that all reported the annual reduction in energy consumption, and the percentage reduction this amount represented of initial lighting consumption. With this data, and with assumptions of installed costs, electricity prices, and lifecycle estimates[xxi] respectively, I was able to estimate the annual cost savings from the bi-level upgrades and determine SIR and payback timeframes. Although each of the individual studies surveyed for this meta-analysis provide much more in-depth analysis of the specific retrofits, aggregating the common data points across a range of studies provides more comprehensive evidence as to the effectiveness of bi-level lighting retrofits as an economically prudent and environmentally responsible step that multifamily building stakeholders should pursue. The results from both surveys are as follows in Table 1:

Table 1: DATA FINDINGS

	SIR	Payback	Cost-effective?
CEC Retrofit Survey	1.4	14 yrs	Yes
California Dormitory Meta-Analysis	3.4	6 yrs	Yes

A discount rate of 3% was used to determine the Savings to Investment Ratio

discount rate of 3%). Where savings exactly equal costs, the SIR rating is determined as 1, SIR ratings greater than 1 represent increasingly higher levels of return on investment.

[7] Other buildings were eliminated from the sample because of large increases in energy consumption since the retrofit was performed. CEC staff hypothesized that this was due to installation of large electric appliances (such as central air conditioning or elevator service.

Based on the research performed for this report, bi-level lighting installations are shown to be a cost-effective energy efficiency measure in multifamily common-areas. Not only do energy savings associated with this retrofit measure provide environmental benefits, but building stakeholders reap substantial financial benefits over the lifetime of the technology.

Because of numerous limitations associated with the methodology of these studies (including limited scope and generalized assumptions), these results cannot be seen a statistically significant or necessarily applicable to all buildings.[8][xxii] In order to provide a more comprehensive analysis of the costs and benefits of bi-level systems, a far-reaching analysis would have to be performed based on direct-monitoring of bi-level fixture energy consumption. However, these positive results should be seen as a step forward in promoting widespread acceptance of bi-level lighting systems as a superior technology compared to conventional installations, and provide justification to governmental stakeholders for encouraging adoption of this retrofit strategy throughout efficiency programs.

ALTERNATIVES

In order to determine the most effective strategy for encouraging bi-level lighting retrofits in advance of eventual code-changes (as discussed above), this component of the report will discuss four ongoing energy efficiency programs in New York: the NYS Division of Housing and Community Renewal's (DHCR) Weatherization Assistance Program (WAP); the NYS Energy Research and Development Authority's (NYSERDA) Multifamily Performance Program (MPP); the Greener Greater Building Plan's (GGBP) lighting retrofit mandate; and the NYSERDA-administered Green Jobs Green Homes New York (GJGH) statewide retrofit program. In providing an overview of each of these programs, specific policy avenues for the encouragement of bi-level lighting systems will be identified.

Lastly I will provide a recommendation for the encouragement of bi-level systems based on the following criteria: the scope of the alternative's ability to widely encourage bi-level retrofits; the amenability to technology-specific encouragement of relevant stakeholders; and the expediency of the alternative in distributing the benefits of bi-level lighting technology to NYC multifamily buildings.

Weatherization Assistance Program.

The federal Weatherization Assistance Program (WAP) is administered at the national level by the Department of Energy (DOE). Every year the United States budget provides a funding allotment for WAP, which is then distributed to state and tribal governments through a DOE formula. Though states vary in the procedures for distribution, most states (New York included) have a roster of WAP implementers (primarily community development and not-for-profit organizations) that receive contracts to retrofit a certain number of low-income units (defined as earning 60% or less of state median income) per program year. Because WAP contract-funds are allocated on a per-unit basis, more extensive and progressive efficiency investments can be made in multifamily buildings as compared to single-family homes.[xxiii]

The primary requirement for expenditure of WAP funding is that energy efficiency investments achieve a SIR greater than 1. Because of this requirement, ongoing DOE program evaluation reports that every dollar spent on Weatherization provides $1.89 directly in energy savings (and 2.69 in further economic benefits).[xxiv] As shown previously, in most multifamily buildings with common-area lighting, a SIR of 1 is easily achieved through bi-level lighting retrofits. However, because most low-income multifamily buildings that receive lighting retrofits have particularly inefficient incandescent lighting systems, a qualifying SIR can be achieved with minimal compact fluorescent upgrades. Although the DOE provides a level of retrofit-measure guidance through material-standards in the federal regulations, there is no explicit reference to bi-level lighting systems as a more efficient retrofit measure than minimal fluorescent upgrades. Although it is unclear the extent to which WAP-implementers in NYC already perform these measures, without explicit

[8] In fact, California researchers state that: "The key research variable [of bi-level lighting's applicability to individual buildings] is the stairwell's occupancy profile. A variety of factors influence the use of a stairwell. These include the number of floors, the location of the stairwell within the building, the likelihood of interaction between floors… and whether or not the stairwell is locked from the inside to prevent inter-floor access."

guidance from WAP administrators, it is likely that less-sophisticated community development WAP-implementers do not take advantage of technically superior lighting systems in achieving highly efficient retrofits.

The specific strategy for encouraging deployment of bi-level lighting systems through WAP involves reaching out to DOE to recommend that material-standards incorporate specific bi-level lighting standards. CEC should also reach out to the Association for Energy Affordability (AEA) and other NYC Weatherization implementers to ensure that they're making full use of this important technology.

Scale – The potential scale for WAP to deploy bi-level lighting systems throughout NYC multifamily buildings (as well as the country as a whole) is substantial. The 2010 budget provided more funds for the program than any year since inception, and the American Recovery and Reinvestment Act (ARRA) made additional multi-billion dollar allocations to the national program. With unprecedented funding levels, New York's DHCR established a multifamily-targeted Temporary Weatherization Provider program to make more expedient use of funding. Through ARRA alone, CEC will be obtaining $30 million in contracts to retrofit approximately 4,700 units[xxv] strictly in multifamily buildings. On top of CEC's expertise with multifamily building retrofits that include bi-level systems, engaging with other permanent and temporary weatherization providers in the metropolitan area could transform the market for bi-level lighting technologies.

Feasibility – It is highly likely that DOE and DHCR would include material-standards relevant to bi-level lighting technologies if a sustained advocacy effort was pursued. Although DOE and DHCR maintain a 'technology neutral' approach to sponsoring retrofits (meaning that they won't be willing to explicitly mandate bi-level lighting), engagement with oversight staff that directly interact with WAP implementers across the state could provide an assessment of the prevalence of bi-level installations. Because higher-efficiency retrofits benefit all stakeholders, it is likely that less-sophisticated WAP implementers would be highly motivated to make use of CEC's technical expertise in modeling, procuring, and installing these systems.

Time – Because CEC and state-wide WAP implementers are already allocating funding to multifamily buildings based on the Temporary Weatherization Provider program, it is important for CEC to pursue relationships with DHCR and other WAP implementers in the immediate future. Every multifamily common-area lighting retrofit that is performed without making use of bi-level technology is a missed opportunity for deeper energy savings.

MPP – NYSERDA.

The Multifamily Performance Program (MPP) is the primary low-income retrofit program sponsored directly by New York State. Through the Public Service Commission's (PSC) Energy Efficiency Portfolio Standard (EEPS), a minimal fee is included in all New Yorkers' electricity bills. Through this funding NYSERDA, along with National Grid and ConEdison in NYC, administer a wide variety of commercial and industrial efficiency programs, including the residentially targeted MPP. This program formed a significant component of CEC's efficiency work up until its temporary suspension in July 2009.[xxvi] The program was suspended by the PSC due to concerns of over-commitment of funds, substantial project delays, and a redesign of the retrofit eligibility standards. The most significant aspect of the mandated redesign is that projects will no longer be approved based on overall project-wide cost-effectiveness, and each measure to be installed and financed through MPP incentives, must meet Total Resource Cost (similar to SIR in providing cost-effectiveness ranking) requirements on its own. Although this is seen among environmental stakeholders as a regressive change to the program (there will be less flexibility for retrofit implementers to install measures that achieve deeper energy savings, such as innovative renewable technologies),[xxvii] the prospects for bi-level lighting retrofits to be included in any given retrofit project are improved.

Discussion with NYSERDA staff indicates that MPP is expected to resume in July 2010 under the new regulations. Final program development and review procedures are currently being performed with the PSC and it is expected that new retrofit projects will be underway by the end of the current year. The most effective avenue for encouragement of bi-level lighting systems through MPP entails direct engagement with NYSERDA in the final

stages of program redesign and continuing into the implementation phase. As NYSERDA reaches out to contractors in disseminating rule-changes, CEC should encourage program-language that makes specific reference to bi-level lighting as a multifamily retrofit measure that achieves high levels of efficiency. Additionally, due to concerns about the long-term relevance of CFL-based lighting systems,[xxviii] CEC should ensure that manufacturers of bi-level systems, such as Lamar Lighting Corp, are producing lighting systems that are compatible with LED-fixture standards.

Scope – NYSERDA projects 14,103 units will receive electric retrofits by the end of 2011,[xxix] all of these multifamily buildings represent an opportunity for installation of bi-level lighting in common areas. Although MPP is not as large as WAP in terms of funding or quantity of retrofits, the building-owner centered nature of the program entails a larger range of contractors involved in program implementation.[9] If NYSERDA is willing to take an active role in disseminating information and strategies related to bi-level lighting among approved contractors, a lesser number of housing units will directly benefit than through WAP, but the potential for market-transformation in the efficiency sector is substantial.

Feasibility – Although PSC and NYSERDA similarly maintain a 'technology neutral' approach to retrofit programs, the encouragement of bi-level lighting systems may be particularly feasible in the context of the new measure-specific cost-effectiveness rating system. An emphasis on the eligibility of individual measures will encourage MPP implementers to pursue higher-efficiency gains from each individual retrofit measure. Similarly to WAP, the introduction of higher-efficiency technologies benefit all stakeholders; NYSERDA and MPP implementers will be open to including bi-level lighting as a standard retrofit measure in multifamily buildings both in NYC and across the state.

Time – Because MPP will not resume until the second half of 2010, CEC should spend the interim period reaching out to NYSERDA staff to discuss avenues for including reference to bi-level lighting in contractor approval standards and revised program materials. When MPP retrofit programs resume later this year, bi-level lighting systems should be included as a common retrofit measure wherever EEPS funds are expended.

Greener Greater Building Program – Lighting Mandate.

As discussed in the policy literature component of this report, the most progressive lighting-related efficiency effort directed toward NYC multifamily buildings is Mayor Bloomberg's Greener Greater Buildings Plan lighting retrofit mandate. Through this mandate, all buildings larger than 50,000 square feet (sf) and all city-owned buildings are required to upgrade lighting systems to at least CFL energy efficiency levels by 2025. This plan is being implemented alongside a similarly targeted 'retrocommissioning' mandate, whereby all large buildings are required to perform energy efficiency audits at least once every ten years starting in 2013,[xxx] and take steps to improve the operational efficiency of current building systems. Although the standards for lighting retrofits make no specific reference to bi-level technologies,[xxxi] in a situation where lighting systems are being replaced anyway, the addition of bi-level capacity is a minimal further investment compared to the substantial energy and cost-savings shown above.

Beyond a legislative amendment to mandate bi-level systems in common-areas affected by the program, the most effective way of encouraging bi-level adoption is through direct engagement with building owners and contractors involved in retrocommissioning and lighting system upgrades. CEC's ongoing relationship with the Mayor's Office of Sustainability provides a valuable venue for the distribution of bi-level related studies and procurement techniques to a wide range of building stakeholders.

Scale – Since this program will apply to all buildings larger than 50,000 sf, the widespread incorporation of bi-level technologies into common area lighting retrofits would substantially impact the market for procurement, manufacture and installation of bi-level systems. It is estimated that common area systems for 22,000 buildings will be impacted by the legislation.[xxxii]

Feasibility – Because owners of buildings larger

[9] These contractors also perform efficiency work in commercial and industrial facilities, a sector which is not considered in this report but also provides valuable opportunities for energy efficiency.

than 50,000 sf are required to replace non-efficient lighting systems before 2025, and due to the attractive energy and cost-savings associated with marginal investment in bi-level capabilities, the Mayor's Office of Sustainability should find it easy to convince building stakeholders to adopt bi-level lighting systems over the course of this program. However, the fact that the initiative for this overarching program lies primarily with Mayor Bloomberg, there is a risk than subsequent mayoral administrations may be less concerned with environmental efforts, allowing GGBP lighting mandates to languish.

Time – Unfortunately, it is unlikely that large building stakeholders will make investments in lighting upgrades far in advance of the 2025 mandate (besides those who would have done so anyway). However, this also provides CEC with a longer timeframe in which to deepen its relationship with the Mayor's Office of Sustainability, and promote bi-level strategies as an effective energy efficiency technique for multifamily buildings. If bi-level lighting strategies are not already industry standard for new construction and retrofits by the time this mandate comes into effect, this program will provide a valuable long-term and widespread avenue for the encouragement of bi-level lighting.

GJGHNY – Constituency Based Organizations.

The final policy avenue for encouraging bi-level lighting technologies this report will discuss is the upcoming Green Jobs Green Homes New York (GJGH) program. Spearheaded by the Center for Working Families (CWF), New York legislation provided funding for this program in October 2009, drawing on a pool of auction proceeds resulting from the Mid-Atlantic and New England Regional Greenhouse Gas Initiative (RGGI).[xxxiii] Although legislation places the program under the administration of NYSERDA, CWF continues to play a strong role in program design and coordinating community and contractor stakeholders across the state. The purpose of this program is to provide a revolving loan fund that will finance retrofits across the state at zero upfront costs to residents or building owners. The costs of the retrofits and administration associated with the program will be paid back over the lifetime of the efficiency investment, reducing overall costs for ratepayers.[xxxiv] Furthermore, CWF and NYSERDA are currently determining 'economic justice' standards (living wage and local hiring requirements among others) for retrofit contractors who will gain work through the program.

A core component of this program is the idea of decentralized implementation. In summer 2010, NYSERDA will be awarding bids across the state for organizations to fulfill positions as Constituency Based Organizations (CBOs). These CBOs (potentially comprising of partnerships between unions, contractors and community groups) will be charged with outreach and intake strategies for the program, as well as with developing contractor relationships with aggregated groups of similarly constructed housing for retrofits. Through this 'bundling' process efficiencies of scale will allow bulk purchasing and standardized installation techniques to be applied to a wide range of housing across the state. Because of higher-density housing in NYC, retrofit strategies specific to multifamily buildings will need to be developed in the context of GJGH implementation. CEC should take an active role in providing technical expertise to whatever CBO partnerships are designated for NYC. CEC's technical expertise in the field of multifamily retrofits can be used to ensure that bi-level lighting systems are deployed in as wide a range of buildings as possible.

Scale – Program designers and supportive stakeholders are highly optimistic as to the scale of GJGH implementation. CWF's initial policy blueprint outlined a scenario in which one million housing units will be retrofitted in the next 5 years. Although NYSERDA has yet to release guidelines for the multifamily component of GJGH, it is likely that NYC's multifamily housing stock will benefit greatly from this program. CWF imagines that 15% of funding would be spent on multifamily retrofits, suggesting that up to 150,000 multifamily units could benefit from bi-level lighting retrofits in NYC.[xxxv]

Feasibility – Because of the decentralized nature of GJGH, CEC should be able to take a leadership role in NYC implementation. Beyond the retrofits that will be performed directly by CEC, management staff and energy experts at CEC should provide technical consulting to CBOs and contractors that participate in program implementation. Due to CEC's reputation as a sophisticated energy services provider in the metropolitan region, it is likely that CWF and other GJGH stakeholders will look favorably on CEC's involvement in NYC implementation.

Time – Because legislation stipulates that program implementation must begin within 6 months of passage, the latter half of 2010 will see the formation and designation of CBO-implementers. CEC should ensure that it engages with NYSERDA and CWF as program guidelines are finalized and CBO partnerships developed. Once CEC's role in GJGH implementation is solidified, bi-level lighting can begin to be deployed through the multifamily component of GJGH, probably in the first half of 2011.

CONCLUSION

Although limited, the technical component of this report provides evidence as to the cost-effectiveness of bi-level lighting as a retrofit measure in multifamily common areas. Lighting efficiency stakeholders should continue to advocate for the encouragement of bi-level lighting through building-code revisions as further technical studies are produced. Despite the lack of experience with bi-level systems among real-estate and development stakeholders, proponents of higher building-efficiency should continue to advocate for the installation and retrofit of bi-level lighting systems in multifamily common areas. Wherever these systems are installed, building owners improve the livability of their units, reduce operating costs, and decrease carbon emissions associated with energy consumption.

Although it will likely be at least a decade before bi-level systems are mandated through building codes in New York City, there are multiple avenues for the encouragement of bi-level retrofits that Community Environmental Center should pursue in the mean time. Specifically, by working closely with forthcoming and ongoing energy efficiency retrofit program administrators, CEC can make a substantial impact on the widespread deployment of bi-level systems.

In pursuing strategies to mitigate global climate destabilization, governmental and civil society stakeholders will be forced to adopt a wide range of new technologies that decrease the environmental impact of our shared infrastructure. Bi-level lighting retrofits for multifamily buildings represent only a small component of the overhaul that will be needed to create truly sustainable urban environments. However, because bi-level lighting systems represent a cost-effective strategy for decreasing energy consumption and improving livability, governmental and programmatic policy should be widely and expediently adapted to encourage the deployment of bi-level lighting systems in New York City and throughout the world.

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End Notes:

[i] Community Environmental Center – Technical Services, Page 9
[ii] Epstein Shari, Rubinstein Francis, Page 9
[iii] Office of the New York City Council
[iv] Warren, Willard
[v] Community Environmental Center – Technical Services, Page 3
[vi] Urban Green: NYC Green Codes Task Force
[vii]Ibid
[viii] Warren, Willard
[ix] Leigh Richard
[x] Urban Green: NYC Green Codes Task Force, Pg 36
[xi] Warren, Willard
[xii] California Energy Standards
[xiii] Papamichael, Konstantinos
[xiv] California Lighting Technology Center: http://cltc.ucdavis.edu/
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[xv] Community Environmental Center – Technical Services
[xvi] Architectural Energy Corporation
[xvii] Huang, Da-Wei
[xviii] Office of the New York City Council (including pie chart)
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[xx] Special thanks to Barbara Tillman of Grenadier Realty Corp
[xxi] Architectural Energy Corporation
[xxii] Ibid
[xxiii] Chalk, Steven
[xxiv] See http://www.weatherize.org/roi.html
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[xxvi] State of New York Public Service Commission, December 16th, 23rd
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[xxx]Office of the New York City Council
[xxxi] New York City Council, Administrative Code
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[xxxiii] New York City Council, Administrative Code
[xxxiv] Center for Working Families
[xxxv] Ibid