A New High Performance Lighting Program Model:
Outperforming Energy Codes while Mandating Premium Efficiency and Quality

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Abstract

Traditionally, the focus of new construction lighting programs has been on the promotion of energy efficient technologies. These programs typically require premium efficiency lamps and ballasts, while some also promote premium efficiency lighting fixtures. More recently, programs administered by National Grid, NSTAR, Public Service of New Hampshire and Efficiency Maine have added lighting quality criteria for some measures, addressing such areas as uniformity, glare, color rendering, etc. An ongoing problem with programs of this type is that it is possible that projects use more energy than energy codes or standard practice dictate. The paper will demonstrate that energy codes are not well enforced and that some projects qualify for incentives while not meeting energy code provisions. In such cases, the goal of promoting efficient technologies is met, but the overriding goal of energy conservation is not.

This paper focuses on new programs that offer incentives for lighting projects that outperform code requirements on a lighting power density (LPD) or watts per square foot basis. Unfortunately, these programs may provide incentives for projects that utilize outdated, inefficient technologies or achieve low LPDs by under-lighting spaces or "massaging" the calculation process.

This paper will chronicle the development of a hybrid "Performance Lighting" program adopted by efficiency programs in the New England states for 2006. This innovative program requires that the LPD outperform energy code requirements by at least 25%, while maintaining lighting efficiency and quality (IES recommended lighting levels; premium efficiency illumination equipment; glare, color rendering, uniformity management). In the future, case studies of actual projects will be used to demonstrate successes and failures of earlier program models, while newly installed projects will be studied to assess the effectiveness of the performance programs. *(Note: the first projects under the 2006 program are now being installed; case studies will be included in the ACEEE presentation.)*

Introduction

The focus of new construction, lighting programs, that offer incentives to end-users, has typically been on the promotion of energy efficient technologies. These programs typically require premium efficiency lamps and ballasts, while some also promote premium efficiency lighting fixtures. More recently, many of these programs have added lighting quality criteria, addressing such areas as uniformity, glare, color rendering, etc. An ongoing problem with programs of this type is that it is possible for qualifying projects to use more energy than energy codes or standard practice dictates. In such cases, the goal of promoting efficient technologies is met, but the overriding goal of energy conservation and project energy efficiency is not.

Recently new programs have been introduced that offer incentives for lighting projects that outperform code requirements on a lighting power density (LPD) or watts per square foot basis. Problems exist with some of these programs such that they may provide incentives for projects that

utilize outdated, inefficient technologies or achieve low LPDs by under-lighting spaces or "massaging" the calculation process.

During the fall of 2005, ERS worked with NSTAR Electric and National Grid in the development of a hybrid "Performance Lighting" program that has been adopted by efficiency programs in the New England states for 2006. This innovative program requires that the LPD levels achieved outperform energy code requirements[1] by at least 25%, while maintaining lighting efficiency and quality (IES recommended lighting levels; premium efficiency illumination equipment; glare, color rendering, uniformity management). Case studies of actual projects will be used to demonstrate successes and failures of earlier program models, while newly installed projects will be studied to assess and demonstrate the effectiveness of the performance programs.

Program Background

The two sponsoring utility companies, NSTAR Electric and National Grid have been operating similar energy efficiency programs in New England for more than a decade. The programs often offer identical lighting measures for commercial and industrial customers. Although they also offer custom programs, the overwhelming percentage of participation is through the prescriptive program paths available through the Energy Initiative (retrofit/replacement), and Design 2000 (new construction/major renovation).

These programs started out with very simple measure requirements focusing on certain lamp and ballast technologies. Over the last ten years they have gradually become more sophisticated and have included such measures and requirements as:

- High efficiency recessed troffers (over 83% overall efficiency)
- High efficiency deep cell parabolic fixtures (installed to IES RP-1 specifications for glare control)
- High efficiency pendant indirect fixtures (installed to IES RP-1 specifications for glare control and ceiling brightness factors)
- High Intensity T5 High Bay and Low Bay fluorescent fixtures
- High-Performance "Super" T8 lamp/ballast combinations

These and other recently introduced lighting measures, such as daylight dimming systems and high efficiency, low glare, advanced recessed T8&T5 fixtures, have shifted the focus from simple electrical efficiency to an approach that emphasizes efficiency and overall lighting performance. The additional measures have focused on lighting quality in several distinct ways:

1. Promoting fixtures with inherent optical control features to minimize glare and enhance lighting uniformity.
2. For deep cell parabolic fixtures establishing minimum criteria addressing direct and indirect glare, by requiring that the fixtures installed, in any space type, comply with the "preferred maximum luminances" criteria of the IESNA RP-1 1993 standard. This criteria was established to control glare at typical viewing angles (55,65,77 and 85 degrees from vertical) in offices with VDTs.
3. For pendant indirect and direct/indirect fixtures addressing glare and lighting uniformity by requiring that installations comply with the uniformity of ceiling luminance, maximum ceiling brightness, and average brightness at certain viewing angles (45, 55 and 90 degrees from vertical) criteria of IESNA RP-1 1993 Standards.

[1] Chapter 13 of the Massachusetts Building Code (Energy Conservation Code) is a modified version of ASHRAE Standard 90.1

4. For high intensity fluorescent high-bay and low-bay installations, controlling average direct glare by restricting fixtures of 125-219 watts to mounting heights of at least 16', and fixtures of 220 watts or more to 20' or greater mounting heights.

Although RP-1 was developed by the IESNA for office environments. The NGRID and NSTAR programs have applied RP-1 glare and uniformity recommended practices to all space types where the relevant fixture styles are being installed. For example, RP-1 glare standards were adopted for all installations of deep-cell parabolic fixtures and indirect pendant fixtures being installed in classrooms, hallways, lobbies, retail spaces, etc, in addition to office spaces.

Additionally the two companies participated in the Northeast Energy Efficiency Partnership's DesignLights™ Consortium and program staffers utilized design guides (KnowHow Series) and case studies from this regional effort to promote lighting quality along with efficiency.

Without question these program enhancements offered significant improvements and have moved the energy efficiency lighting market to focus more on overall lighting performance. Customers have received better projects with higher levels of visual performance, and ratepayers are investing in projects that have a higher level of persistence in the marketplace.

However, under these program models it has been possible, and indeed it has frequently occurred, for projects to receive energy efficiency incentives even when the connected wattage (energy demand) is higher than state energy efficiency codes allow, and/or standard practice would dictate. It is important to understand that energy efficiency codes in the Northeast are not well enforced, and in many jurisdictions are not enforced at all. The States of Massachusetts and Rhode Island rely on "self-enforcement" of the commercial construction energy efficiency codes. The self-enforcement of the code involves the designers or project owners providing a signed statement that energy code provisions are met. Rarely are plans or projects reviewed for energy provision compliance by code officials. During 2005, ERS and the sponsoring joint Massachusetts utilities investigated energy code compliance documentation, visiting city and town code offices throughout the State. No evidence of project review for energy code provisions was discovered, and the knowledge of energy code provisions and compliance methodologies, such as ComCheck-EZ software, was extremely limited. Although a large percentage of the design community attempts to comply with the energy code provisions, there are many exceptions due to code misinterpretation or a reluctance to shift from well-established customs such as illuminating retail, classroom, and office spaces to levels that were recommended decades ago. ERS reviews many projects for utility companies in the Northeast and can cite numerous projects that received technology based incentives for designs that did not meet energy code provisions. These have included a large department store with LPD levels 75% higher than code levels, a large public school with LPD levels 30% higher than code levels, and a commercial office building with LPD levels slightly higher than code levels and no, code required, automatic controls installed.

Another problem associated with this generation of programs is that the measure performance criteria were found to be restrictive and confusing. Program staff rarely gained an understanding of the RP-1 criteria and were often unable to successfully review project applications. Lighting designers and electrical engineers were frustrated by the strict application of RP-1 glare control requirements, finding them too restrictive for many projects, especially when glare requirements intended for office environments with VDT terminals were extended to other space types. Feedback from program participants, vendors, and technical assistants was that many good project opportunities were lost, with project owners reverting to standard technologies when the program requirements appeared onerous.

During the last two years the requirements of these programs have been eased somewhat, with simplified documentation approaches being offered and RP-1 based performance criteria being recommended instead of being required for incentive eligibility.

Although these recent changes have eased the burden on program staff and have allowed project designers more flexibility, the sponsoring utilities began to look at lighting programs that have fewer individual measure performance criteria and that were focused primarily on demonstrated efficiency higher than required by energy codes, focusing on overall energy performance criteria such as lighting power density.

The First Generation "Performance Lighting" Program

During 2005 NSTAR began offering its "Performance Lighting" program which pays an incentive based on wattage reductions obtained by designing lighting power density (LPD) levels that are lower than those required by the Energy Code's lighting power allowances (LPA). This differed from NSTAR and National Grid's Design 2000 Custom Lighting programs, which pay incentives calculated on the incremental construction costs and energy savings comparing a standard practice design with the proposed design, paying a maximum of 75% of the incremental expense for upgrading to the proposed efficient design.

Although this program basically worked well, several issues appeared during the debut program year. Some projects qualified for incentives simply by incorporating designs that supply lighting levels at or below the lower range of IESNA recommended lighting levels, utilizing standard practice technologies and techniques. These projects save energy, but are doing so by reducing the number of fixtures or the number of lamps per fixture, rather than incorporating efficient technologies or enhanced design features. In effect, standard projects were receiving incentives.

Additionally, reviewing program applications has proven to be very difficult. In an effort to keep the program simple to use, documentation requirements were kept minimal. Program administrators had a goal of keeping the actual application to one-page in length. The goal was met, but at a cost. The required documentation is not rigorous enough to assure that program LPD and minimum fixture requirements (power factor standards, harmonics, etc.) are met, or that post installation programmatic evaluations can be successfully performed.

As discussed in the previous sections, over the last several years, prior to the introduction of this first generation Performance Lighting Program, both NSTAR and NGRID have promoted lighting quality factors such as lighting uniformity, color rending, and glare reduction, along with efficiency. Unfortunately, with the first generation NSTAR Performance Lighting Program, these issues were not addressed and lighting quality issues have not been a factor in the qualification process.

Additionally, the program documentation methodology of using energy code compliance software (COMcheck) reports for program compliance has not been successful, as code enforcement is virtually non-existent and the software allows the user to input any lighting fixture wattage desired whether it is accurate or not.

Project applications under the first generation program have been reviewed by both NSTAR administrators and outside technical assistance contractors, including ERS. All have found the review process to be unworkable. Instead of reviewing the applications, the reviewers have found the need to start fresh and prepare new applications and compile project documentation. The result has been a burdensome process leading to substantially revised or even rejected applications leading to customer dissatisfaction.

Other program issues include:

- Applicants gaming the system by calculating lighting power density using the total building area when only portions of the building are being included in the incentive application
- The improper mixing of residential and commercial spaces, including disallowed spaces – crawl spaces, storage bins, etc. – in the building area calculations.

Other Relevant Program Models

In preparing the proposed second generation Performance Lighting program, ERS researched other program models that utilize lighting power density calculations in calculating incentive levels. Two programs had the most relevance.

Efficiency Maine Lighting Program – The new construction/major renovation prescriptive and custom programs operated by Efficiency Maine both contain provisions that require lighting power densities be achieved that are at least 20% better than Maine energy code (ASHRAE 90.1 2001) levels. Lighting quality is targeted by restricting incentive eligibility to premium technologies including: HP (Super) T8 fixtures; T5 & T5 HO fixtures; High Intensity Fluorescent High/Low Bays; and high efficiency recessed and pendant fixtures incorporating glare control. All lighting applications are reviewed by a lighting designer for program compliance, appropriate technology and design application, and lighting quality issues. As the program grows, lighting quality criteria may become more prescriptive in order to ease the burden on project reviewers who now follow a project-by-project process that is extremely flexible.

Connecticut Light and Power and United Illuminating Programs – The lighting programs offered by these two utilities were developed together and have only minor differences.

For these programs, the lighting incentives are calculated on a formula that is used to demonstrate that the project LPDs significantly outperform the code mandated LPAs. In order to ensure that premium technologies are encouraged, 80% of the project's connected lighting load must be from eligible technologies, regardless of the obtained LPDs.

The eligible technologies include: T-8 or T-5 fluorescent lamps with electronic ballasts; hard-wired, pin-based, compact and circline fluorescent fixtures; high-pressure sodium fixtures; pulse-start metal halide fixtures; and low-voltage halogen fixtures. Incentive qualification and amounts are determined by calculating how much lower the proposed LPD is than the code mandated LPA.

An incentive bonus for the utilization of emerging technologies such as high performance T8 (Super T8) systems, and high intensity fluorescent fixtures is also offered. Both CL&P and UI offer a bonus in addition to the standard incentive when emerging technologies are employed. The bonus is applied with a “reasonableness” factor (as determined by program staffers performing project reviews) that considers the additional energy savings, the incremental cost, and the specific measure application; the maximum bonus offered is $20 per fixture.

A problem with this program model is that the savings calculation methodology, rather than being based on percentages, is based on direct total wattage reductions. Maximum incentive levels are paid when the wattage reduction reaches 0.4 watts per square foot. Using this formula, it is much easier to qualify for the maximum incentive levels for areas that have higher code lighting power density allowances than it is for areas that have low allowances. For example, it is easy to save total wattage for retail spaces that have a maximum power allowance of 1.9 LPD, but difficult

to save total wattage for warehouses that have a maximum allowance of 0.6 LPD. For this reason, most of the applications have been for offices, retail spaces, and schools.

Lighting Power Density Allowance Considerations

The maximum LPD levels allowed by codes and standards are referred to as the lighting power allowance (LPA). The LPAs for ASHRAE 90.1 based codes and standards were developed jointly by ASHRAE and the Illuminating Engineering Society of North America (IESNA). The LPAs were established by modeling various building and space types utilizing "current design practices" and "generic luminaires." The two organizations model 124 individual building/space types with three technologies modeled per space. With the exception of spaces such as gymnasiums and warehouses, the modeling is done with fluorescent fixtures using commonly available technologies.

This extensive modeling of spaces assures that the LPAs that are selected for 90.1 standards will allow lighting levels to be achieved that are within the range recommended by the IESNA for each space type, using current design practices and readily available, cost-effective, energy efficient equipment.

Common LPA levels utilized by various programs include:

- ASHRAE 90.1 2001 – The standard upon which most programs and codes are based
- Massachusetts Energy Code – Essentially identical to ASHRAE 90.1 2001 levels
- ASHRAE 90.1 2001 Addendum g (2003) – On average approximately 20-25% stricter than ASHRAE 90.1 2001 levels. Some space types such as gymnasiums, warehouses, and sports arenas were modified dramatically, while others received smaller adjustments. Virtually all space types were modified.
- ASHRAE 90.1 2004 – Only minor changes from ASHRAE 90.1 2001 Addendum g (2003)
- Advanced Buildings Guidelines Benchmark 1.1 – Essentially equal to ASHRAE 90.1 2001 Addendum g (2003) levels
- Federal 2006 Tax Credit Program (EPACT) – 25-40% stricter than ASHRAE 90.1 2001 levels
- Proposed 2006 NSTAR/NGRID Performance Lighting Program – minimum of 25% stricter than ASHRAE 90.1 2001 levels using a space-by-space or building area approach.

Table 1
Sample Lighting Power Allowances

Building Type	Mass Energy Code	ASHRAE 90.1 2001	ASHRAE 90.1 2001 Addendum G June 2003
Transportation	1.2	1.2	1.0
Warehouse	1.2	1.2	0.8
Office	1.3	1.3	1.0
Police/Fire Station	1.3	1.3	1.0
Convention Center	1.4	1.4	1.2
Court House	1.4	1.4	1.2
Exercise Center	1.4	1.4	1.0
Town Hall	1.4	1.4	1.1
Library	1.5	1.5	1.3
Automotive Facility	1.5	1.5	0.9
Dining: Bar Lounge/Leisure	1.5	1.5	1.3
Dormitory	1.5	1.5	1.0
Performing Arts Theater	1.5	1.5	1.6
School/University	1.5	1.5	1.2
Sports Arena	1.5	1.5	1.1
Hospital/Health Care	1.6	1.6	1.2
Museum	1.6	1.6	1.1
Gymnasium	1.7	1.7	1.1
Hotel	1.7	1.7	1.0
Workshop	1.7	1.7	1.4
Dining: Cafeteria/Fast Food	1.8	1.8	1.4
Retail	1.9	1.9	1.5

Modeling Lighting Performance for the 2006 Performance Lighting Program

As covered in the previous section, ASHRAE and the IESNA together perform extensive modeling to assure that proper lighting performance can be obtained at the LPA levels established in 90.1 standards. Because the ASHRAE 90.1 2001 Addendum g (2003) LPA levels have been extensively modeled, it can be reasonably certain that adequate lighting performance can be achieved at the similar LPA levels proposed for the 2006 Performance Lighting Program.

However, the Performance Lighting Program encourages lighting designers to do better than the program required minimum 25% level. Additionally, the program sponsors have been promoting certain ballast, lamp, and fixture technologies for the past several years through their respective efficiency programs. For these reasons it was deemed important to model a variety of typical space types with the relevant technologies to make certain that proposed programs goals are achievable.

ERS modeled six space types with a variety of efficient lighting technologies in order to demonstrate that the proposed program would be workable with the technologies that the sponsors wish to promote. A total of 40 models were generated representing typical space/fixture combinations. The lighting modeling tool AGI 32 was used to generate all of the models. AGI 32, a product of Lighting Analysts, inc. is a computational program that performs numerical point-by-point calculations of incident direct or reflected light on surfaces or imaginary planes. In order to

assure relevancy to the sponsors programs, actual spaces from prior NSTAR and NGRID program projects were used.

The spaces modeled include:

Space Type	Number of Models
Gymnasium	5
Lobby	3
Large Open Office	9
Small Office	12
Warehouse	5
Retail	6
Total	**40**

The technologies modeled include:

- T8 Lamps & Electronic Ballasts
- High Performance (Super) T8 Lamp & Ballast Systems
- T8 Lamps with Low-Power Ballasts
- T5 Lamps & Electronic Ballasts
- T5 Biax Lamps & Electronic Ballasts
- T5 HO Lamps & Electronic Ballasts
- Compact Fluorescent Lamps & Electronic Ballasts
- Ceramic Metal Halide Fixtures
- Pulse & Probe Start Metal Halide Fixtures

The fixture types modeled include:

- Parabolic Troffers
- High Efficiency Prismatic Troffers
- Recessed Indirect
- Recessed Volumetric
- Pendant Indirect
- Pendant Decorative
- Retail Display
- Recessed CFL
- High Intensity Fluorescent
- HID High Bay

Table 2 below presents a summary of our simulation results.

Table 2
Summary of Modeling Results

Space/ Building Type	Mass Energy Code Allowed LPD	Performace Lighting Program Allowed LPD	Target FC	Fixture Type	Design LPD	Average FC	Comments
Open Office	1.3	1.0	50	Pendant Direct/Indirect w/Regular T8	0.928	51.8	
				Pendant Direct/Indirect w/T5HO	0.983	51.9	
				Pendant Indirect w/HP T8	0.884	53.6	
				2x4 High Efficiency Parabolic w/Regular T8	0.825	57.0	
				2x4 High Efficiency Trofffer w/HP T8	0.750	53.8	
				2x4 Volumetric Fixture w/T5	0.591	48.0	
				2x2 Volumetric Fixture w/T5HO	0.780	52.2	
				2x4 Recessed Direct/Indirect w/T8	0.990	54.0	
				2x2 Recessed Direct/Indirect w/F40Biax	0.990	47.5	
Enclosed Office	1.5	1.1	30	Pendant Direct/Indirect w/Regular T8	1.029	35.4	
				Pendant Direct/Indirect w/T5HO	0.843	24.1	
				Pendant Indirect w/HP T8	0.757	23.7	
				2x4 High Efficiency Trofffer w/Regular T8	0.629	33.1	
				2x4 High Efficiency Trofffer w/HP T8	0.571	29.5	
				2x4 Volumetric Fixture w/T5	0.900	42.1	
				2x2 Volumetric Fixture w/T5HO	0.743	29.3	
				2x4 Recessed Direct/Indirect w/T8	1.257	39.3	Non-qualifying
				2x2 Recessed Direct/Indirect w/F40Biax	1.029	28.5	
				2x2 Parabolic w/T8 U-bent	0.857	34.5	
				2x4 High Efficiency Parabolic w/Regular T8	0.857	35.1	
				2x2 Recessed Direct/Indirect w/T8	1.514	31.6	Non-qualifying
Retail Space	1.9	1.5	50	2x4 High Efficiency Parabolic Retail w/Regular T8	0.700	46.6	
				1x4 Retail Recessed Fixture w/HP T8 (Zumtobel style)	0.767	51.0	
				2x4 High Efficinecy Lens w/Regular T8	0.800	49.2	
				Recessed Ceramic Metal Halide Retail	1.055	50.1	
				Pendant Ceramic Metal Halide Retail	1.055	50.3	
				1x4 Reflectorized Strip w/Regular T8	0.650	49.8	
Lobby (General Illumination)	1.8	1.4	10	7" Recessed CFL	0.708	17.9	
				24" Pendant Direct/Indirect Dome	0.708	11.1	
				Pendant Indirect w/Regular T8	0.625	16.6	
Gymnasium	1.7	1.3	50	High Intensity Fluorescent w/T5HO	0.975	57.3	
				High Intensity Fluorescent w/Regular T8	0.750	59.8	
				High Bay Compact Fluorescent	1.567	50.5	Non-qualifying
				High Bay PSMH	0.938	49.4	
				High Bay MH	1.138	47.6	
Warehouse	1.2	0.9	30	High Intensity Fluorescent w/T5HO	0.488	28.4	
				High Intensity Fluorescent w/Regular T8	0.375	25.2	
				High Bay Compact Fluorescent	0.940	24.5	Non-qualifying
				High Bay PSMH	0.625	30.0	
				High Bay MH	0.758	29.0	
Classroom	1.6	1.2	50	Pendant Direct/Indirect w/Regular T8	1.136	44.3	
				Pendant Direct/Indirect w/T5HO	1.194	43.7	
				Pendant Indirect w/HP T8	1.082	45.4	
				2x4 High Efficiency Parabolic w/Regular T8	0.943	55.8	
				2x4 High Efficiency Trofffer w/HP T8	0.857	51.7	
				2x4 Volumetric Fixture w/T5	0.900	56.2	
				2x2 Volumetric Fixture w/T5HO	0.990	50.3	
				2x4 Recessed Direct/Indirect w/T8	1.257	52.1	
				2x2 Recessed Direct/Indirect w/F40Biax	1.371	48.9	

Assumptions:

- NGRID and NSTAR program "listed" wattage for ballast/lamp combinations was used for all calculations
- All spaces modeled within a category are identical in size and surface reflectance
- All fixture spacing is within manufacturers' recommendations

The modeling demonstrates that with careful selection of efficient technologies and fixtures, all space types modeled have the potential for program participation. The following observations can be made regarding the modeling:

2x2 Biax Fixtures – The limited efficiency of this fixture style makes it hard to qualify under the program. None of the parabolic 2x2 biax layouts met the qualifying criteria and were

dropped from further consideration. The layouts featuring recessed indirect styles are marginal with two of the three sample layouts qualifying.

High Performance Recessed "Volumetric" Fixtures – Due to high efficiency and advanced optical control, this style is well suited to the program

Gymnasiums/HIF Fixtures – It may be wise to reduce the qualifying LPD for this space type. The allowed wattage under the Energy Code is high, leading to incentives that are higher than those for other space types. ASHRAE has made this same modification to subsequent versions of 90.1.

Pendant Indirect – This style works best when lighting levels are at the low end of the IESNA recommended lighting levels. This is acceptable as this style of fixture illuminates the ceiling and achieves high overall perceived brightness levels allowing for lower lighting levels, while maintaining good visual performance and occupant satisfaction.

Maintaining Lighting Quality

The sponsoring utility companies (NSTAR and NGRID) have attempted in recent years to promote lighting quality in consort with energy efficiency. Uniformity, glare reduction, color rendering and other quality issues have become integral parts of their programs especially for office and classroom environments. Unfortunately this focus was substantially lost in the development of the first generation NSTAR Performance Lighting Program. One of the main goals of this proposed program is to re-incorporate lighting quality issues into the Performance Lighting model.

This could be done by incorporating a set of qualifying criteria, and/or specifying that project designs should conform to appropriate IESNA lighting quality criteria. We have incorporated such language in the proposed program qualifying criteria. It was decided to not require adherence with IESNA criteria, as the IESNA requests that such criteria only be used as a guideline. Previous experience of the sponsoring utilities with requiring that specific IESNA criteria be met led to many excellent projects being disqualified and ill-advised design changes that were made only to meet programmatic criteria. Additionally we have developed a two-tiered approach, detailed in the next section, which will promote lighting quality along with advancing technologies.

Promoting Advancing Technologies

The goal of efficiency programs is to not only reduce the electrical demand and consumption of the participating projects, but also to promote and demonstrate advancing technologies in order to move them to the mainstream marketplace. The new construction program administered by CL&P and UI does this by offering two tiers of incentives. The second tier is a bonus of $20. per fixture installed for installing advancing technologies.

The 2006 Performance Lighting Program follows a somewhat different, two-tiered approach, as offering a per-fixture bonus would unnecessarily mix two program models. Instead the program provides an enhanced incentive per watt of demand saved when advanced technologies are incorporated. The current NSTAR Performance Lighting Program offers $0.75 per watt of demand saved compared with Energy Code levels. We recommend that the levels be set at $0.40 and $0.80 for the two tiers of the program.

Adopted rules for a two-tiered approach:

- **Tier 1** ($0.40 per watt saved) – With the exception of specialized task, medical, and emergency lighting, all lighting installed must be of energy efficient design.

Excluded from program participation are incandescent lamps/fixtures, mercury vapor lamps/fixtures, and fluorescent fixtures with magnetic ballasts.

- **Tier 2** ($0.80) per watt saved) – In addition to the Tier 1 rules, at least 75% of the lighting fixtures installed in the project must be of the following qualifying types:
    - High Performance "Super" T8 (see list) fixtures with overall efficiency ratings of at least 75%.
    - T5 or T5 HO fixtures with overall efficiency ratings of at least 75%.
    - LED Display Lighting
    - Ceramic Metal Halide Display Lighting
    - Other Innovative Lighting Technologies Determined on a Project-by-Project Basis

In order to illustrate the probable incentive levels achieved under the program and to compare them with existing prescriptive incentives, we used the modeled spaces to test a sample of the space/fixture types. Table 3 illustrates our findings.

Table 3: Incentive Samples

Space Type	Mass Energy Code Allowed LPD	Performace Lighting Program Allowed LPD	Design LPD	Fixture Type	Total Number of Fixtures	Saved Watts	Performace Lighting Program		NSTAR Construction Solutions	NGRID Prescriptive Program	
							Tier	Rebate		Code	Rebate
	W/sq.ft.	W/sq.ft.	W/sq.ft.			W		$			$
Open Office	1.3	1.0	0.928	Pendant Direct/Indirect w/Regular T8	168	3576	Tier 1 - $0.4/Watt	$1,430	N/A	33	$5,040
Open Office	1.3	1.0	0.884	Pendant Direct/Indirect w/HP T8	168	3996	Tier 2 - $0.8/Watt	$3,197	$1,680	33A	$5,880
Open Office	1.3	1.0	0.800	Pendant Indirect w/HP T8	152	4800	Tier 2 - $0.8/Watt	$3,840	$1,520	33A	$5,320
Gymnasium	1.7	1.3	0.975	HIF Fixtures w/T5HO Lamps	20	3480	Tier 2 - $0.8/Watt	$2,500	$800	57	$800
Warehouse	1.2	0.9	0.758	PSMH	20	6900	Tier 1 - $0.4/Watt	$2,760	$200	52	$200
Warehouse	1.2	0.9	0.488	HIF Fixtures w/T5HO Lamps	25	8550	Tier 2 - $0.8/Watt	$6,840	$1,000	57	$1,000
Classroom	1.6	1.2	0.943	High Efficiency Trofffer w/Regular T8	9	552	Tier 1 - $0.4/Watt	$221	$135	30	$135
Classroom	1.6	1.2	0.900	High Efficiency Trofffer w/HP T8	9	624	Tier 2 - $0.8/Watt	$499	$180	30A	$180
Classroom	1.6	1.2	1.082	Pendant Direct/Indirect w/HP T8	18	435	Tier 2 - $0.8/Watt	$348	$180	33A	$630

Table 3 illustrates that there would be some dramatic shifts in the total incentives paid for certain technologies for the sample space types. The incentives for pendant mounted indirect fixtures will go down in comparison with NGRID's prescriptive program, but will be higher than the current NSTAR prescriptive program. The two utility companies endorse the new numbers as NGRID believes that the installation of pendant indirect fixtures have become much more accepted as a standard practice, and NSTAR has experienced a decline in prescriptive applications for this measure. The other glaring example pertains to warehouse spaces. The high potential incentives under the Performance Lighting program are due to the fact that the Massachusetts Energy Code's LPA values are based on the original ASHRAE 2001 90.1 figures. ASHRAE realized that the LPA associated with warehouses was too high and dramatically reduced the allowance when they published addenda g. NSTAR and NGRID will use the addenda g figure for the program baseline for warehouse spaces.

Adopted 2006 Performance Lighting Program

The program adopted for 2006 is outlined below:

Program Assumptions

1. Anticipating the 2006 Federal Tax Credit Program that will allow credits for lighting systems that beat ASHRAE 2001 by 25%; set program required LPD levels to 25% better than 90.1 2001.
2. Consider "ASHRAE 2001" to be as originally published (not including the addenda, as addendum g specifies much stricter LPD levels than Massachusetts code and the Federal Tax Credit Program).
3. Participants may not mix and match space-by-space and building area methods.
4. Control the use of the application for building/space types that have very high LPAs, such as "manufacturing" and "sport courts" as the lighting needs are highly variable and free-ridership is at issue.
5. Promote advancing technologies.
6. Maintain high quality lighting.

Program Rules and Procedures

Incentives may be provided for lighting projects that obtain Lighting Power Density (LPD) levels significantly lower than the Lighting Power Allowance (LPA) levels mandated by Chapter 13 of the Massachusetts Building Code (Energy Code) or ASHRAE 90.1 2001. The LPD may be calculated using the Building Area Method or the Space-by-Space method. Exterior lighting and parking garage lighting are not eligible.

All projects that qualify under this program must:

- Be new construction projects or renovation projects that involve the installation of new fixtures throughout the building or renovated spaces.
- Provide maintained lighting levels in accordance with the recommendations of the Illuminating Engineering Society of North America (IESNA).
- Provide high quality lighting achieving appropriate levels of glare control, color rendering, lighting uniformity and other lighting quality parameters deemed important by the sponsoring utilities. The rules concerning lighting quality are being developed as this paper is being completed. Preliminary lighting quality guidelines are discussed in the next section.
- Meet the "Terms and Conditions" set forth by the utility company
- Meet all the requirements as specified in the application document.

Preliminary Lighting Quality Program Guidelines

As previously discussed, the sponsoring utilities have experienced issues with integrating IESNA recommended practices as programmatic requirements. For this reason the program rules will not require that any IESNA criteria for glare and uniformity be adhered to. The final program rules are being negotiated at the same time that this paper is being submitted. However, the sponsors have decided on an approach that promotes lighting quality through a variety of methods, allowing lighting designers flexibility in their approaches.

Preliminary Lighting Quality Related Requirements and Recommendations:

- Required: Minimum CRI criteria for all T5 and T8 and compact fluorescent lamps.
- Required: Electronic IES photometric files to be included with submittals.
- Tier II (double the incentive value compared with Tier I) to promote indirect pendant fixtures and advanced recessed fixtures such as the LedaLite Pure FX, Lithonia RT5, and Metalux Accord.

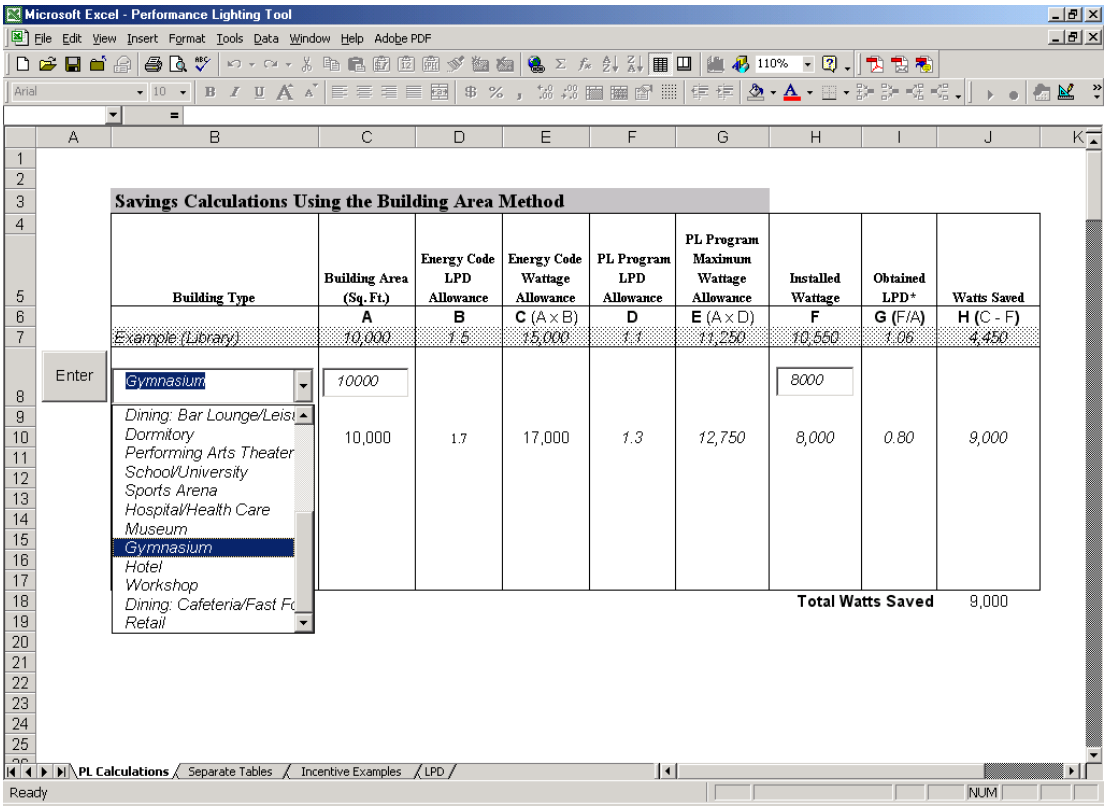
- Project designers will be encouraged to consult the IESNA series of "Recommended Practice" Standards: RP-1 (Office Lighting); RP-3 (Educational Facilities); RP-29 (Health Care Facilities) and other IESNA standards relevant to the projects.
- All utility company representatives implementing the 2006 Performance Lighting Program will be required to receive training in lighting quality issues.
- All 2006 Performance Lighting projects to be reviewed and modeled by experienced lighting professionals. (This requirement is considered temporary as program personnel may take on a portion of this responsibility over time.)

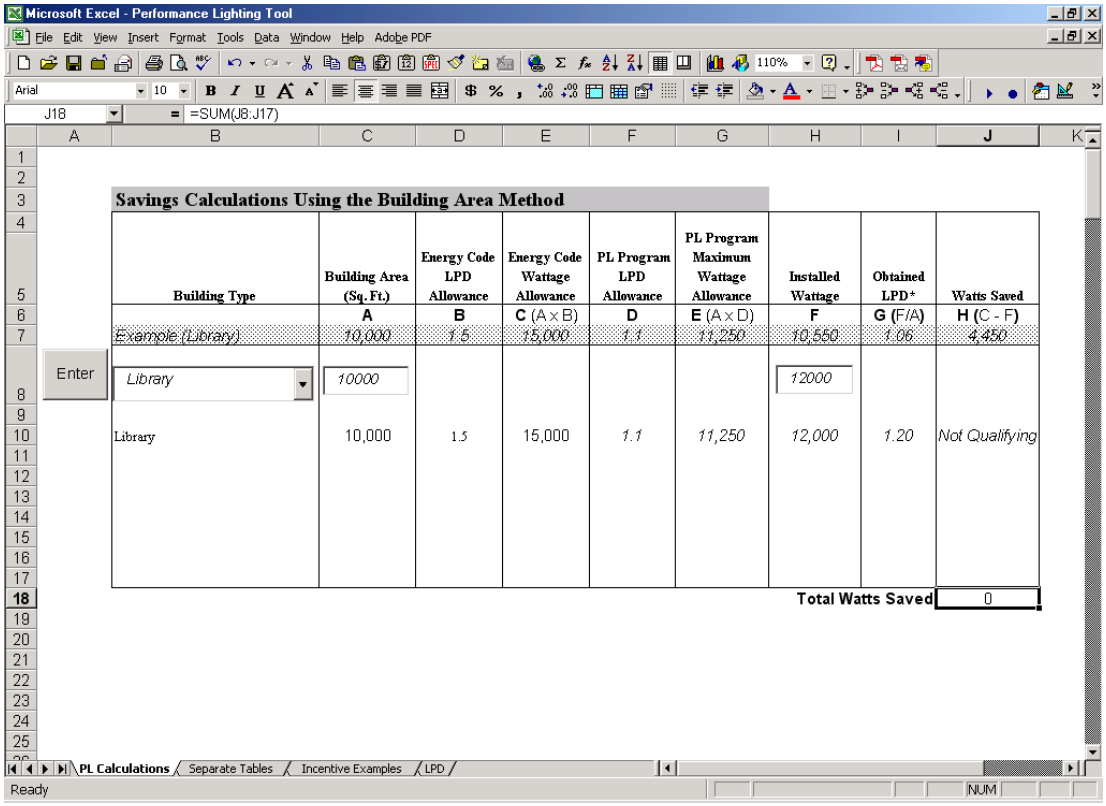
Performance Lighting Program Software

After final program parameters were established, ERS developed a program calculation and compliance software tool with drop-down menus. This is by far the most elegant and accurate method for calculating incentives and minimizes clerical errors and program gaming. All fixture wattages are input from dropdown menus that contain the rated wattages accepted for each ballast/lamp combination eligible for program inclusion. The tool not only calculate incentives, but also automatically warns when LPDs drop below 40% less than code levels so that the lighting design can be checked for adequate lighting levels. At the program administrator's discretion, the tool may be used by utility staff or distributed to design professionals.

Table 4 illustrates two screen shots from the tool.

Table 4
Performance Lighting 2006 – Software Tool





Conclusion

Energy efficiency lighting programs have come a long way in the last decade. Simple lamp and ballast programs have been replaced by programs that promote efficient fixtures along with efficient lamp and ballast technologies. More recently, programs have focused on lighting quality; rightly assuming that if lighting quality is kept high, less light is needed and occupant satisfaction will lead to better program persistence. The latest program models have focused on making certain that projects receiving incentives have lower connected electrical loads than energy codes and standard practice dictate. The 2006 Performance lighting program combines the best features of the various program models in an effort that promotes advancing technologies, high quality lighting, and low lighting power density levels.

References

ANSI/ASHRAE/IESNA Standard 90.1-2001: Energy Standard for Buildings Except Low-Rise Residential Buildings. 2001. American Society of Heating, Refrigerating, and Air Conditioning Engineers.

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Program Documentation:

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