Application of Commercial Sector Energy Code Compliance Documents for Assessing Baseline Practice

Assessing Whether Compliance Documents Can Be Used for Developing Lighting Baseline Data

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ABSTRACT

Attempts to understand energy end-use baselines for different technologies are critically important for understanding current practice in the marketplace, determining energy efficiency technical potential, developing effective efficiency programs, and properly evaluating new construction and lost opportunity programs. Unfortunately, there are challenges in developing accurate baseline data; secondary sources of data may have limited applicability and collection of primary data with appropriate detail can be costly.

This paper discusses an assessment of an alternative approach to development of baseline data for lighting that uses energy code compliance reporting documentation. This paper describes an ongoing effort that uses these compliance documents to assess baseline characteristics. The focus of this current effort is on lighting systems since this end use can be captured in considerable detail in the COMcheck-EZ compliance software and is shown in output reports. Documentation reports present whole building or space-by-space lighting power density, and may show specific details of types of technologies used in each building space. Since there is a legal requirement for submission of the described compliance documents, this information should represent a comprehensive source of recent activity describing the current practice and the baseline in a region.

As this paper indicates, even with legal requirements in place, there are some significant challenges that arise associated with gathering and using the data. Initially, we had been concerned that compliance reports, which are generally submitted to local towns or municipalities, may not be viewed as public record, or may not be available for numerous reasons. Further, we believed the quality and accuracy of the COMcheck-EZ software compliance reports would be highly variable. Next, we were concerned that the designed condition as represented in the compliance reports may be dramatically different than the as-built condition. Finally, we noted that many new construction projects are built without ever having followed energy code compliance requirements, and no appropriate documentation is available.

This paper discusses the details of our efforts to use the compliance reporting documents for the assessment of baseline practice. We will describe numerous aspects of the process such as the ability to gain access to the reports, the quality of reports, content detail or reported design data, limitations of the documents, and the general effectiveness in their use in baseline development. We will also describe associated site data collection efforts conducted to confirm compliance document accuracy. Finally, we will comment on the frequency of new construction projects that do not comply with the requirement to submit COMcheck-EZ (or equivalent) reports.

Introduction

The effective development and implementation of any energy efficiency program requires an understanding of those systems that are installed or would be installed in the absence of the program. Baseline technologies or assumptions, frequently developed through an understanding of standard practice, represent the program assumption of the standard efficiency to which an installed energy efficient system is compared. Accurate development of the baselines to be used by various programs is critical for accurate development of project and program savings estimates. That said, it is a considerable challenge to develop baseline data. Typically, extensive research studies would be required, involving costly on-site data collection efforts addressing facilities of all sectors, sizes, and characteristics.

This paper is focused on an investigation of an alternative approach for lighting baseline development that could be far less costly. During the past several years there has been an enhanced effort to promote state adoption of new and more aggressive energy codes. To date, more than 50 percent of US states have adopted new energy codes. In the commercial sector, one requirement of most states' energy code compliance reporting process is the submission of COMcheck-EZ software reports. Such reports include a summary of some of the key energy performance features and technologies, demonstrating that submitted new construction designs do indeed meet code mandates.

The project outlined in this paper has the objective of determining if the discussed compliance documentation on file at municipal building inspector offices can be used as a primary source of data for characterizing lighting design standard practice and baseline development in Massachusetts. Further, our approach must assess: 1.) the practicality of extracting key information from filed documents (through surveys and data collection at representative building inspector offices); and 2.) whether the documents reflect as-built conditions.

While the document submission requirements for energy code compliance are quite clear, energy codes (in Massachusetts and elsewhere in the US) do allow variability in what is explicitly provided. There is much additional variability in: how submissions are handled; what is considered acceptable by each code official or municipality; the types of data provided for different size or sector projects; the type of information provided by Architectural and Electrical (A&E) designers vs. contractors; and the detail of information that those submitting parties provide. This can be further complicated by the variability in code officials and different municipalities, *i.e.*, how much scrutiny energy code submissions receive, how well records are maintained, and whether records can be made available for public review. The challenge in this project lies in recognizing that many factors can arise that may create potential challenges to the accessibility, value, and usefulness of the collected data as a source for developing baseline lighting information.

Discussion of Typical Compliance Documents

As stated, there is variability in the documentation that will be submitted to code officials, and variability in what the specific municipality will require. Thus several different documents, submitted in support of project compliance, may be available from the municipal code official files for those projects. These include:

- **Statement or Affidavit of Compliance** – The licensed professional involved in the design of the project may simply provide a statement that the project is compliant with the Massachusetts (MA) Energy Code (Chapter 13 of the MA Uniform Building Code).

- **COMcheck-EZ** – This software tool, developed by the US Government's Pacific Northwest National Laboratory (PNNL), facilitates reporting of lighting project compliance with MA Energy Code's lighting power density allowances, either on a whole building or space-by-space basis. This software is simple to use, requiring basic technology line item data entry along with associated building or space areas. Outputs are simple to understand and can provide some insights into design lighting power density and technologies. Some designers may simplify inputs, potentially making technology specifications too general for defining a standard practice.
- **Other Lighting Analysis Reports** – Other comparable spreadsheet or software tools may be able to perform the same function as COMcheck-EZ. Such tools can be used for determining whether a lighting design meets the code-allowable lighting power densities. Outputs or printouts from such custom tools may be found as part of compliance documentation files.
- **Energy Code Narrative Report** – The MA Energy Code requests a basic "Narrative Report" that discusses the proposed building energy systems, project characteristics, and compliance with the energy code. Such documents are intended to be brief, perhaps 2-5 pages in length. The reports may outline the features of the lighting design that indicate compliance with the MA Energy Code.
- **Comprehensive Design Documents** – Project files in support of general and energy code compliance typically can include architectural and engineering drawings and design specifications. These documents can certainly provide more than adequate details to demonstrate the as-designed characteristics of the lighting system. Unfortunately, technical review of such documents to determine lighting code compliance or standard practices would represent a costly and timely exercise.

Project Approach & Methodology

This section provides a task-by-task discussion of the approach that was undertaken for conducting the assessment of code compliance documents for developing standard practice data. This approach includes: detailed on-site interviews and data collection meetings at a modest sample of municipalities; review of and collection of data from a selection of project files data from the municipalities; and site visits to building sites to compare file data with actual as built conditions.

Municipal Office Surveys

This initial and key task involved detailed interviews with code officials at the candidate communities. During these visits ERS staff met with between one and six representatives of the community who handled different aspects of building project design code review and inspections. We asked numerous questions addressing how they conduct their work. These officials were asked the general nature and quantity of projects observed in their town, the types of compliance documents that are regularly collected, the officials' awareness of the energy code concepts and details, how they ensure code compliance, and how and what records they maintain.

At the onset of this project, ERS had anticipated many challenges in collecting information and data from the municipal code official offices. While this task has a fundamentally basic objective, ERS believed there would be challenges in gaining access to the building inspectors or code officials, and then potential challenges in gaining access to files and in determining if files have sufficient data. There are several key aspects to this task: selection of communities for office surveys; incentives to promote community participation; characteristics of the office survey (including a community data collection survey protocol); selection and review of project files; review of project lighting system design and appropriateness; and preparation of individual municipal code office reports.

The task required that we work to effectively characterize the document filing process, the experience of accessing records, and the quality of those records. While we initially believed we would find success in working with code officials in many municipalities, we believed there would be some additional significant administrative and technical obstacles that must be overcome if the project is to be successful and effective. Some of these obstacles include:

- **Code Official Defensiveness** – There is great variability in the capabilities and diligence of code officials. Further, the role of code officials is typically not focused on the energy codes or energy end use technologies; rather, their role is very broad and includes codes addressing every aspect of buildings design and construction. Those officials that do not have a thorough understanding of the energy code, or have not spent sufficient time in project review associated with the energy code chapter, may be reluctant to offer access, in general, or perhaps limit access to only their most exemplary projects.
- **Part-time Code Officials** – Some code officials work in a part-time capacity, particular in smaller communities or communities with fewer resources. Part-time officials may be less inclined to facilitate access, they may be too busy to allocate time to an outside assessment, and finally, they may be unable to arrange time outside of their limited hours.
- **COMcheck-EZ Limitations** – The COMcheck-EZ software functions as an excellent tool for entering general line item wattages, but the technology options are limited. For some increasingly common technologies there are no basic COMcheck-EZ data entry categories. These include, for example, T-5 and pulse start metal halide technologies. Users must either manually fill in the line item description, or just list the line as an available technology, hopefully with the proper system wattage.

Selection of Communities and Data to be Addressed – For this assessment to be effective and for primary and secondary research questions to be answered accurately and fully, the sample of municipalities surveyed must effectively bracket the considerable variability expected, including:

- Quality and Types of Compliance Documentation Submissions
- Code Officials (capability; level of scrutiny; expectations; and record keeping)
- Level and Type of Activity (number of projects; types of projects; project vintage; building sectors; facility sizes; new construction vs. renovation; etc.)
- Design and Construction (architects; engineers; lighting designers; contractors; etc.)
- Efficiency Program Activity Level (including communities with both high and low levels of activity in efficiency programs)

Municipality Office Administrative and Code Enforcement Process – In conducting surveys of the municipalities and their code officials, we have assessed the administrative process of the code officials in their efforts to support compliance with the energy code and specifically, the lighting elements of the code. This administrative assessment has looked at those aforementioned details such as general office accessibility, types of data collected, level of scrutiny that the project submissions receive, filing system for project specific data, and the access provided to that data. We have also sought to understand the breadth of project types observed in the community, including building sector and size, types of submitting parties, project age, and overall quantity of submitted projects.

Project File Data Collection – At each surveyed municipality, ERS also gathered data on several specific building projects. The quantity of projects sought at each office was dictated by the desired

building site visit sample (plus an over-sample quantity) for field data collection in that municipality. The sample project, as appropriate, was selected so that it also was representative of the type and sizes of projects found in that community.

Once projects were selected, data was gathered from the files. In most cases, it was possible for actual files and selected drawings to be copied, in which case much of the assessment and technical review of the documents could be done at ERS' offices. As part of our project file assessment, we reviewed the lighting design, addressing more open-ended characteristics such as design and technology quality and appropriateness, as well as information on selected equipment, controls, power densities, and calculation methodologies and selected approach (whole building or space-by-space).

Municipality Office Site Reports – Following completion of each municipality code office survey, the project team reviewed notes on the administrative processes observed and the data collected. Using this information, for each site we developed a community site report that discussed all aspects of the administrative process, how that process could impact the ease and usefulness of gathering building project data associated with energy code compliance for lighting systems, and the characteristics of the specific building projects for which data was gathered.

The site report for each surveyed community included the following sections:

- **Brief Narrative Discussion** – This is an overview of the visit and a description of the events that occurred and the discussions we had during the site visit.
- **Key Findings for the Community** – This detailed discussion section described:
  - Code Official Review Process – How does the code official or the office handle the compliance review process? Do they actively collect compliance documents and effectively scrutinize the materials that are submitted?
  - Document Storage and File Maintenance System – This explains the process that the specific community uses for storage and maintenance of files on building projects. Who keeps the records? How did we gain access to the files? How long are records maintained? How regularly are detailed documents filed at the building inspector offices?
  - Method of Accessing and Accessibility of Building Project Files – This addresses the general ability to access building files. How available are the documents? Do code or community officials make them available? How long are they available? Are there times of the year when access is easier?
  - Contents of Typical Files – This section describes the typical contents of building project files. It lists the types (COMcheck-EZ, narrative discussion, etc.) and frequency of different compliance documents found in the files, and addresses whether they are generally complete and effective for the task of determining lighting system standard practice (i.e., is quantity and technology detail provided and sufficient?)
  - Building Projects and Types – This section discusses the quantity and types of buildings in process.
- **Sample Project Files** – The site report also includes copies of the key documents for the sample buildings for which we subsequently have conducted lighting system verification surveys.

Building Surveys

The next major effort undertaken for the project was site surveys of a sample of buildings for which files had been collected during the municipal site surveys. The objective of the building site surveys is to compare file documentation and data with the actual as-built condition, thus determining whether file data is or can be an accurate representation of the as-built condition and the lighting system installation.

As discussed, during the municipality office site visits we selected a number of recently completed commercial construction projects. For each candidate site, we gathered contact and project background information from the code official. Prior to site visits, in an effort to best understand the characteristics of the site, the following efforts were undertaken.

- **Determine Utility Program Participation** – Because this was intended to be an evaluation of standard practice conditions, it is important to identify those projects that have received incentives and or technical assistance through utility DSM programs. Those projects that have been influenced by the applicable energy efficiency programs are effectively not of the same population element as those sites for which selected equipment was not driven by the programs.
- **Interview Design Professionals** – For each project that was developed with the help of design professionals (architects, electrical engineers, lighting designers) the project team interviewed the design team members as to their knowledge and intent regarding the application of the energy code. We also gathered data on general characteristics of that design team's approaches to selection of lighting equipment and their interest in energy efficiency.

In addition, prior to actually going on-site, the field data collection engineer reviewed program files collected from the community for the sampled site, with the objective of gaining a complete understanding of the project and the compliance documentation and lighting design details. Then, utilizing the code compliance documentation and other information collected from the file, a site-customized survey tool was prepared for each site, prompting the surveyor to look for specific lighting system installation details.

- **Lighting Fixtures Types** – This is the most critical of the site survey details. Lighting surveys are often thought of as the "counting of light bulbs". However, the utility companies sponsoring this effort manage sophisticated incentive programs that promote the installation of premium efficiency and premium performance lighting fixtures. The survey process needed to be effective in identifying such fixture and illumination system details as: low and high power ballasts; special high efficacy lamps; special lamp & ballast combinations; premium efficiency fixtures; construction details such as depth of parabolic louvers; etc. Details of each lighting and fixture type are recorded, including:
  - Exact lamp type (example F32 T8 – 835)
  - Quantity of lamps per fixture
  - Ballast type including manufacturer's catalog number
  - Fixture description including manufacturer's model number (when available)
  - Fixture efficiency as identified with manufacturer's cut sheets
- **Lighting Fixture Counts** for each space/design type as well as each fixture type
- **Architectural Dimensions** for each of the spaces or the building area to be used for lighting power density calculations
- **Local Manual and Automatic Lighting Controls Installed**
- **Centralized and Programmable Lighting Control Systems**

Following each building site survey, the project team: reviewed the data; compared information gathered on-site with project file data; utilized spreadsheet tools to calculate code compliance; tabulated as-built site data; and developed an effective and concise site report.

Analyses and calculations were also performed for each site. These included:

- Rated Wattage for each Fixture Type
- Space-by-Space Lighting Power Density Calculation
- Entire building Lighting Power Density Calculation
- Connected Load for each Automatic Lighting Control

The summary site report for each site addresses a number of different topic elements, as follows:

- Brief Narrative Description of the Project
- Discussion of Project File Data
- Summary of Key Findings for the Site
- Full Description of Each Fixture Type Installed, including:
  - Generic Description (i.e. 2x4 3 lamp parabolic 4" deep cells)
  - Fixture Manufacturer Model Number (when available)
  - Lamp Type (i.e. F32 T8 835 ES)
  - Lamp Quantity
  - Ballast Type (e.g.: electronic low power)
  - Ballast Catalog Number for Predominant Systems
  - Rated Wattage of Ballast/Lamp Combination
  - Fixture Attributes (e.g.: Specular Reflective Surface)
  - Fixture Rated Efficiency
- Space-by-Space Lighting Power Density Achieved
- Entire Building Lighting Power Density Achieved
- Lighting Control Code Compliance
- Comparative Analysis of Code Compliance Documentation and As-Built Findings
- A Table Illustrating the Above Comparison Including kW and kWh Effects
- Discussion of and Apparent Reasons for any Discrepancies

Summary of Findings

The assessment project, to date, has addressed eight (8) municipalities, for which comprehensive interviews and data collection have been conducted. We collected project files from each of the community code official offices. Using these files, twenty (20) building surveys have been conducted, addressing the relevance of the project file data in characterizing standard practice for lighting.

The project is a work in progress, so we are hopeful that the latter stages of our efforts will show some variation in our findings to date. While there has been a degree of variability between municipalities in types of projects being built, as well as in overall practices, our findings to date have

been quite clear and consistent in demonstrating that development of lighting baseline data from information available at community code official offices would be difficult or impossible. Our findings during the community surveys demonstrated that standard practice was not easily, readily, or explicitly observable from data gathered, reviewed, or maintained at municipal building offices. The following points summarize our key findings.

- **Municipal Code Enforcement Office Practices** – In contrast to our expectations at the start of the project, we came to understand that all towns surveyed had limited understanding of the codes and collected wildly variable information that addressed energy code compliance details. Some of our key observations are:
  - Code officials do view building project records as public and do make them available. We had no difficulty in getting full copies of individual project files.
  - There is little understanding of energy code requirements, in general or specifically. Most code officials do not understand the general energy code requirements, not to mention lighting requirements. Further, even those that have been trained in the requirements and the use of tools such as COMcheck-EZ, claim to have little understanding of the use or interpretation of results.
  - There is considerable turnover in code official offices. Education of code officials regarding energy code requirements may be valuable, but due to the transition of staff, may have a short term effect.
  - Records that explicitly demonstrate lighting energy code compliance, such as COMcheck-EZ reports, summary spreadsheets, and narrative discussions of code compliance, are infrequently collected or maintained, and vary greatly in completeness and accuracy.
  - Some municipalities promote and enforce code compliance through project meetings attended by the design team and building code officials. The resulting decisions are typically not documented.
  - In general, compliance with the energy code is determined through a general affidavit by the project architect or other party involved in the project. This basic statement makes claim that the building is in compliance with all code requirements (not just the energy code). Thus, typical code officials place the responsibility of enforcement in the registered architect or firm handling the project, and with the aforementioned affidavit, focus on some limited aspects of the code for their enforcement activities.
  - Code officials typically view occupant health and safety as their primary overriding concern. Energy provisions are often dealt with only as time allows.
  - COMcheck-EZ allows the user to easily change input information, such as fixture wattage, while keeping a running tab on energy code compliance. This has led some users to simply modify inputs, regardless of the accuracy of such inputs, until compliance is demonstrated.
  - Complete sets of design drawings are most often available at community offices, though these may be stored off site due to size of the documents. Design plans, however, frequently do not reflect the as-built conditions for new building or major renovation projects, and may not be useful for accurately determining compliance or installed technologies.
- **Building Site Survey Practices** – For the buildings that we surveyed, we saw a wide variation in practices, with reasonable, but not exclusive agreement with some of the data found in the project files associated with lighting systems and code compliance. Key observations include:

- Pre-site visit discussions with design professionals seems to be the easiest way to get an understanding of design approach and specific actions taken to comply with the energy code requirements.
- As-built conditions frequently differ from design conditions and intent. Designs and file records that demonstrate energy code compliance do not necessarily imply code compliance in the installed, as-built project. Energy code compliance is most likely to be ensured when the project involves knowledgeable architects and engineers, who design in accordance with the code, and then stay involved in the project (along with project installation managers) to ensure contractors do not make changes that compromise compliance and project quality.
- Architects and engineers are frequently receptive to sharing and explaining project plans and documents, including energy code compliance documents. Their files may be very helpful for reviewing project details and assessing lighting baseline practices.
- Building site surveys do demonstrate that many (not all) projects are indeed energy code compliant. That said, documents obtained from community code official offices have not been helpful in determining compliance, or in assessing lighting baseline practices.

Recommendations

The project described in this report produced results that the sponsors of this project were not anticipating. Since the objective of the effort was to determine whether municipal offices' files could be useful for developing standard practice data, we can claim success in that we definitively determined the answer: code official office files are not useful as an explicit source for baseline data development.

With all of that in mind, despite the less than optimal findings, the project has been useful and we believe we are closer to a somewhat more simplified approach for developing baseline data, albeit a different approach than expected. Fundamentally, through our efforts and specifically based on the discussions we have had with members of the design community (architects, engineers, lighting designers), we believe we have developed an alternative and cost effective means to develop baseline, standard practice data for lighting technologies. This would use in-depth interviews with a sample of the A&E community, followed by inspection of a small sample of buildings. While we are targeting lighting baseline development, we believe the following approach would be applicable for HVAC, building envelope, or other building systems.

As with the current effort discussed in this paper, the proposed baseline development approach would require sponsorship, generally anticipated to be the utilities or state organizations that develop and implement energy efficiency programs. Further, it is likely that some level of incentive might be required to support participation of the various market actors who would be targeted for the proposed study approach.

- **Market-Smart Approach for Baseline Development** – As with the interviews already conducted with the community offices, we would anticipate that sponsorship for this alternative approach would be from the applicable energy efficiency programs. The process would include the following key tasks or steps:
  - Determination of Sample Communities – Rather than develop baseline data using a very broad base of communities for investigation, we believe it will be more cost effective to use a statistically developed sample of communities, representative of overall geography. Those communities would have a large population of new construction projects and a wide range of active architects, engineers, and contractors.

- Gather Data from Code Officials – A valuable piece of information that we did find through the effort described in this paper is that most community's code officials view the information from projects completed in their communities as public, and are helpful and willing to share their knowledge on these projects. This task would involve telephone interviews with these communities to gain a listing of applicable projects, along with associated design firms and contractors.
- Primary Data Collection Interviews with Architects and Engineers – This task would be the primary data collection effort for development of baseline data. It would involve comprehensive interviews with design professionals, review of design plans and documents, and available compliance documentation. Our work through the current effort has provided us with a perspective that the interviewed design professionals would welcome review of their project files and discussions on technologies applied, their understanding of compliance, and changes made to design details during construction. *Note: It may be necessary to provide A&E firms with some type of incentive to motivate participation in these comprehensive interviews.*
- Site Verification – As part of the proposed approach, we recommend that a small sample of those projects for which we gathered data during the design firm interviews, would be subjected to on-site verification. This would enable development of correction factors (addressing design vs. as-built conditions) to be applied to lighting power densities and technologies, thereby improving the standard practice data gathered through the interviews.
- Interpretation, Organization, and Consolidation of Data – At this point, all data collected through interviews and site visits would be interpreted and analyzed, and then tabulated as recommendations for lighting baselines for program application.

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