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Whitepaper: Proposed Revisions to DLC Energy Reporting Requirements

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Contents

Executive Summary

Since 2017, the DesignLights Consortium (DLC) has promoted energy monitoring as a method to encourage broader adoption of networked lighting controls (NLCs). Various stakeholder groups value energy monitoring and energy data reporting; in particular, multiple energy efficiency programs require energy reports from incentivized NLC projects. At present, each program has unique requirements for an energy report, so NLC manufacturers experience burden to create a unique reporting function to serve each program.

Until recently, standards designed specifically for NLCs were not available to support standardized energy reports. The situation has changed with the recent publication of ANSI C137.5-2021 and ANSI C137.6-2021, which describe aspects of the expected accuracy and contents of NLC energy reports. To encourage standardized NLC energy reporting, the DLC plans to align its requirements with these standards and to address additional aspects of energy reporting that are not yet covered by standards.

This whitepaper describes various proposals to make DLC requirements and recommendations for energy reporting more useful to a broader audience. The proposals are based on the new ANSI standards and on input from a working group convened in Q4 2021 comprised of representatives from DLC member efficiency programs and DLC industry partners.

This whitepaper introduces the proposed changes to the Technical Requirements in advance of a public comment period so that stakeholders can consider implementation of these proposals, prepare comments accordingly, and manage product development.

The proposed changes are as follows:

1. Expand DLC Qualified Products List (QPL) eligibility to accept NLC systems capable of storing four weeks of 15-minute interval data and one year of daily interval data at the zone level (as an alternative path, in addition to the present path of storing two years of 15-minute interval data).
2. Recognize the recently published NEMA/ANSI standards C137.5-21 and C137.6-21 that describe aspects of the expected accuracy and contents of NLC energy reports.
3. Require NLC systems to be capable of reporting interval data in .CSV or Excel files, in recognition that efficiency program use cases for energy reports do not include state-change data or API data.
4. Revise the DLC's recommendations for "reported" (i.e., optional) file contents, to address essential topics while minimizing the burden of compliance.
5. Update the existing NLC5 Technical Requirements in Q3 2022 with item number 1 above; followed by more extensive updates in the next major revision of the DLC Technical Requirements to address topic number 2, 3 and 4 above.

This whitepaper is time sensitive. It documents a specific moment in the ongoing development of the DLC requirements for energy reporting and will become obsolete as those requirements evolve with updated draft Technical Requirements in Q4 2022 and beyond.

Introduction

Since 2017, the DesignLights Consortium (DLC) has promoted energy monitoring as a method to encourage broader adoption of networked lighting controls (NLCs). Various stakeholder groups value energy monitoring and subsequent energy data reporting. For energy efficiency programs, energy reports from incentivized NLC projects can help determine incentive amounts and program savings claims for completed projects and can also help calibrate predicted savings on future projects. For building owners, ESCOs, and NLC manufacturers, energy reports can validate energy savings from lighting control projects.

Multiple DLC member efficiency programs require energy reports from some of their incentivized NLC projects. At present, each different program has unique requirements for a qualifying energy report, which places burden on NLC manufacturers to create a unique reporting function to serve each program.

The DLC Networked Lighting Control System Technical Requirements Version NLC5 (NLC5 Technical Requirements) released in June 2020 contain a few requirements for energy reports adapted from ANSI/ASHRAE/IES 90.1 requirements, and a few recommendations developed through the DLC stakeholder engagement process. Since the NLC5 Technical Requirements were released, relevant new industry standards have been published, including ANSI C137.5-2021 and C137.6-2021 (see "Resources" below) describing aspects of the expected accuracy and contents of NLC energy reports.

In Q4 2021, the DLC convened a working group consisting of representatives from NLC manufacturers, member efficiency programs, and program implementers, plus Pacific Northwest National Lab, to explore improvements to the DLC recommendations for energy reporting based on new standards and new understanding of the needs of various stakeholders. The DLC is grateful for the effort and insight provided by the working group participants. This whitepaper describes proposals from that working group, which will be included in the first draft of the next DLC Technical Requirement revision, to be vetted through the DLC stakeholder input process.

Overview of Existing Requirements and Recommendations

The existing DLC description of energy monitoring is summarized below. For more details, the complete technical requirements document Networked Lighting Control System Technical Requirements Version NLC5 is available on the DLC website. The name of this document is abbreviated below as "NLC5 Technical Requirements" or "NLC5".

In the NLC5 Technical Requirements, the word "requirements" describes capabilities that all NLC systems (except room-based systems) *must* offer. The word "recommendations" describes capabilities that are optional, or "reported". Some DLC qualified systems support "recommended" capabilities, and other systems do not. The requirements for energy monitoring that most DLC qualified NLC systems must offer are summarized in the Existing Requirements section below. Additional recommendations for energy monitoring that NLC systems might or might not offer, are summarized in the Existing Recommendations section below.

Existing requirements

NLC5 requires, on page 6, that all DLC qualified NLC systems be capable of energy monitoring, except for room-based NLC systems. The capability of energy monitoring is defined on page 17, Table 3, Row 11. The requirements note that either 15-minute interval data or state-change data shall be available via .CSV file or API for a duration of two years.

The basis of these requirements for energy monitoring was ANSI/ASHRAE/IES Standard 90.1-2016, *Energy Standard for Buildings Except Low-Rise Residential Buildings,* with a three-year record duration shortened to two years in the DLC stakeholder engagement process. The need for 15-minute interval data was derived from the IPMVP[1] Options A and B, as typically implemented by utility programs.

Existing recommendations

In addition to the requirements summarized above, NLC5 provides nonbinding recommendations for the contents of an energy report in Tables EM-1 and EM-2, on pages 6-8.

Proposed Changes to the Technical Requirements

While the DLC requires non-room-based NLC systems to offer the capability of energy monitoring, the DLC cannot validate how products are installed and configured, so thus does not specify whether any required capability is installed on a particular project. For example, in a warehouse with no daylighting, daylight harvesting sensors would typically not be installed, even though the NLC system design supports the capability of daylight harvesting. While the energy monitoring capability is "required" by the DLC to be available on non-room-based DLC qualified NLC systems, this capability is rarely a standard feature. More typically, it is an optional feature that is often omitted from projects due to value engineering. A goal of the working group was to define the minimum viable capability that will serve the primary needs of incentive programs without adding undue cost to NLC projects, so that energy reports will be available on more projects. Note that some efficiency programs do have requirements and validation mechanisms about which NLC capabilities must be enabled in order to receive efficiency incentives for a particular project.

The word "proposed" is used in this whitepaper to designate suggestions for changes that will be considered through the stakeholder input process on both the "requirements" that all non-room-based DLC-qualified NLC systems *must* be capable of meeting and on the "recommendations" that NLC systems *may or may not* be capable of meeting.

Proposed requirements

The DLC Energy Reporting Working Group found that efficiency programs are unlikely to need more than four weeks of 15-minute interval data, or more than one year of daily interval data. The former can be used for debugging purposes, while the latter can be used to track seasonal trends and predict annual

[1] International Performance Measurement and Verification Protocol: Core Concepts and Options for Determining Energy and Water Savings EVO-10000-1.2016, Efficiency Valuation Organization, evo-world.org.

performance. This data is most valuable to efficiency programs during the first year of operation—after that it is nice to have, but not essential.

The working group also found that efficiency programs need interval data in .CSV or Excel-based files. While data transfer via API is desirable for interoperability between NLC systems, and from an NLC system to a master energy dashboard, it does not serve the needs of most efficiency programs. Similarly, while state-change data could theoretically support research into NLC energy savings by different capabilities, it cannot address the primary goal of efficiency programs, which is streamlined, scalable analysis to support streamlined, scalable incentives. ANSI C137.5-2021 Section 5.5.2 specifies the "Reporting Interval… at least once every 15 minutes". Hence, the first draft of the next major DLC Technical Requirements revision will propose that API data exports and state-change data would no longer be recognized by the DLC as ways to claim the Energy Monitoring capability.

Proposed new Table EM-0

A new table of requirements with fundamental project data was proposed to be labeled Table EM-0, as shown below. For reporting accuracy, this table refers to ANSI C137.5-2021, *American National Standard for Lighting Systems—Energy Reporting Requirements for Lighting Devices*.

For spatial granularity, the goal is to record energy usage from groups of luminaires called "zones", because data from every luminaire is often too detailed to support high-level, cursory understanding. Ideally, each luminaire would be in one and only one zone, so that the sum of energy used by all zones equals the sum of energy used by all luminaires. In practice, many types of zones overlap one another, with one luminaire appearing in multiple zones with multiple purposes—so that the sum of energy used by all zones may not in fact equal the sum of energy used by all luminaires. This issue may be addressed by the future standard ANSI C137.9, *Lighting Systems - Networked Lighting Control (NLC) - System Configuration Report* (see Resources section for more details).

For reported units of measurement, there was a discussion between using kilowatt hours (kWh) and Watt hours (Wh). When either unit is used exclusively, data files for some projects will contain many placeholder zeros (to the right of the decimal point for kWh, or to the left of the decimal point for Wh). Nevertheless, the need to minimize confusion and maximize consistency overrode this concern—it was agreed that one unit of measurement should be used exclusively. The group recommended kWh because efficiency programs use this unit of measurement most often; and because the main focus is on groups of luminaires, rather than on individual luminaires where Wh is more appropriate. However, this topic deserves further exploration because ANSI C137.6-2021, *Lighting Systems - Data Tagging Vocabulary (Semantic Model Elements) for Interoperability*, specifies Wh as the default unit of measurement. Note that ANSI C137.6-2021 supports an alternative "Scale Factor" tag, so the kWh unit of measurement could be aligned with this standard by using an appropriate Scale Factor.

Proposed Table EM-0: Efficiency Program Use Case Support Specification Table

Topic	Proposed Requirements
Standard for energy reporting	Conform to ANSI C137.5-2021
Reported energy metric	Period cumulative energy use (not savings)
Reported unit	Kilowatt-hours (kWh)
Spatial granularity	Zones: groups of NLC devices, larger than an individual luminaire and smaller than a whole building, from contiguous areas that make sense based on the function or location of the space.
Reporting format	CSV or Excel file
Record duration and data interval	2 years of 15-minute interval data (as currently required), OR 4 weeks of 15-minute interval data * and 12 months of daily interval data**
Reporting resolution	Minimum resolution of 1 kWh, AND sufficient fractional kWh resolution to match the accuracy level specified in ANSI C137.5-2021. In many zones, over a 15-minute interval, this will be in the ten-thousandths of a kWh (0.1 Wh).

* During the first year after original configuration, the preceding 4 weeks of 15-minute interval data can be reported at any time. For instance, after 4 weeks of a new academic term or new production cycle.

** During the first year after original configuration, daily interval data can be reported since original configuration.

Proposed recommendations

The DLC Energy Reporting Working Group proposed several changes to the two tables of recommendations: Table EM-1 “Recommended Energy Data Reporting Guidelines for .CSV or API; Static Data” and Table EM-2, “Recommended Energy Data Reporting Guidelines for .CSV or API; Dynamic Variables”. One proposed change common to both Tables EM-1 and EM-2 is to remove “.CSV or API” from the titles because the data format will be specified in Table EM-0.

Proposed updates to Table EM-1

The working group proposed to update the recommended fields in Table EM-1 to provide minimal essential information. For instance, in terms of configuration data, details about time-out delays for occupancy are nice to have—but the essential question is whether occupancy or vacancy sensing is enabled in each zone.

To help with program administration, data fields would be added for Site Name, Zone ID, and Luminaire Quantity. Also, ideally, zone-level configuration data would be added for high-end trim, occupancy/vacancy, and daylight harvesting. Exactly how to do that is yet to be determined, and will be further researched with DLC stakeholders.

The following data fields from the current Table EM-1 could be omitted. While they would be useful for research, they are not essential for administration of efficiency programs.

- System Manufacturer
- System Product Brand Name
- Site Building/Business Type
- Energy data method: how is energy data calculated, e.g. "15 minute average from 3 samples spaced 5 minutes apart"
- Energy Reporting Interval (this can be calculated from the difference between sequential timestamps)

Proposed Updates to Table EM-1: Recommended Energy Data Reporting Guidelines; Static Data

Recommended Header	Definition	Unit
Site/System Level Data		
Site name	A uniquely identifiable name of the site of the NLC installation	text
System rated power	Total connected lighting power of the system before controls	kW
Zone Level Data		
Zone ID	A uniquely identifiable name for each group of luminaires that are controlled together	text
Luminaire quantity	The number of luminaires or control devices within each non-overlapping zone	int
Rated power	Total rated power of the luminaires within each non-overlapping zone	kW
Configuration Data*		
High-end trim	The percentage of maximum output power programmed for the zone (e.g., 100% = no high-end trim)	%
Occupancy/vacancy sensing	Indicate whether occupancy/vacancy sensing is enabled for the zone	Y/N
Daylight harvesting	Indicate whether daylight harvesting is enabled for the zone	Y/N

* Luminaires typically belong to multiple, overlapping zones for various functions. A standard is needed to define a set of complete, non-overlapping zones and to define a configuration value(s) for each of these zones. Until such a standard is available, data will not be comparable across various NLC systems and the sum of energy usage from all zones might not equal the sum of energy usage from all luminaires.

Proposed updates to Table EM-2

The proposed updates to Table EM-2 would specify three types of data—Timestamp, Zone ID, and Active Energy. The timestamp should be in a format that supports arithmetic and pivot table grouping in Excel. The ANSI C137.6 standard, page 4, specifies that the "Active Energy" field is by default

"cumulative since device initialization, non-resettable", but supports alternative tags for "periodic: measured over the preceding specified time interval" and for "resettable" data.

Three fields are proposed to be removed from Table EM-2: "Confidence Level" and "Nominal Accuracy" are now covered by ANSI C137.5-2021; and the "Recorded Period" can be calculated from the difference between initial and final timestamps.

Proposed Updates to Table EM-2: Recommended Energy Data Reporting Guidelines; Dynamic Variables

Recommended Header	Definition	Unit	Note
Timestamp	Date and time in UTC when energy consumption is reported based on the reporting duration and data interval	Excel Date & Time Value in UTC	Must support arithmetic and pivot table grouping in Excel
Zone ID	The uniquely identifiable name for the group of luminaires	text	Must match the names in the static data table
Active Energy	The integral of the instantaneous power over a time interval, cumulative since device initialization, non-resettable.	kWh	

Next Steps

This section specifies next steps the DLC will take to collect stakeholder feedback and implement the proposals identified by the DLC Energy Reporting Working Group.

Small change to NLC5 Technical Requirements

Soon after publication of this whitepaper, the DLC intends to update the NLC5 Technical Requirements to recognize four weeks of 15-minute interval data plus 12 months of daily interval data as sufficient; as an alternative to the currently required two years of 15-minute interval data. Two years of 15-minute interval data would still be recognized. This change would enable some products to meet the DLC requirement for Energy Monitoring more easily—and might encourage the installation of energy monitoring on a higher percentage of NLC projects.

Changes in technical requirements through the DLC stakeholder input process

Except for the small change to the NLC5 Technical Requirements mentioned above, other proposals described in this whitepaper will be vetted through the DLC stakeholder input process for the next major revision of the DLC Technical Requirements. Interested parties are encouraged to subscribe to the DLC mailing list for announcements about the comment period at https://www.designlights.org/subscribe/.

The DLC is particularly interested in comments that suggest standardized definitions of a zone or group of luminaires; and standardized ways to assign values such as occupancy and daylight settings to

complete, non-overlapping sets of zones or groups of luminaires. Settings for high end trim, occupancy/vacancy, and daylight harvest can vary in time based on scheduling or configuration updates; and can vary in space in different ways for each capability. In other words, daylight harvest zones are rarely identical to occupancy zones. How can the complexity of an NLC project be represented in a simple way to support a high-level understanding of project operation and energy savings?

Other issues subject to comment will include kWh vs. Wh; whether alternative tags for Active Energy should be recognized per ANSI C137.6; and whether state-change data and/or API data should be recognized by the DLC despite the lack of usefulness for efficiency programs.

Example energy reports

While this whitepaper identifies open issues and proposes ways to address some of those issues, other issues remain unresolved. The DLC aspires to develop examples of energy reports to use as practical aids to implementation.

Conclusion

Multiple energy efficiency programs require energy reports from incentivized NLC projects, but unique requirements from various programs places burden on NLC manufacturers to create a unique reporting function to serve each program.

Until recently, standards designed specifically for NLCs were not available to support standardized energy reports. That situation has changed with the recent publication of ANSI C137.5-2021 and ANSI C137.6-2021. To encourage standardized NLC energy reporting, the DLC plans to align its requirements with these standards and to address additional aspects of energy reporting that are not yet covered by standards.

The proposals in this whitepaper aim to make DLC recommendations for energy reporting more useful to a broader audience, and are based on these new standards and on input from a working group of DLC stakeholders convened in Q4 2021.

A draft of the next major revision of the DLC Technical Requirements will incorporate these proposals, and will be available for public comment through the DLC stakeholder input process. Interested parties are encouraged to subscribe to the DLC mailing list for announcements about the comment period at https://www.designlights.org/subscribe/

Resources

ANSI C137.5-2021

Lighting Systems—Energy Reporting Requirements for Lighting Devices
https://webstore.ansi.org/Standards/NEMA/ANSIC1372021

Specifies the minimum performance requirements for lighting devices that report energy data. These requirements include the specific energy data types to be reported, the nominal and statistical accuracy performance for all reported data types, and references to other standards that define the information model for all data types.

ANSI C137.6-2021

Lighting Systems–Data Tagging Vocabulary (Semantic Model Elements) for Interoperability
https://webstore.ansi.org/Standards/NEMA/ANSIC1372021-2449810

Contains a Controlled Vocabulary of terms for Lighting Systems. These terms enable the development of semantic model elements, e.g., tags, that facilitate the exchange of data and metadata used in control and analytics. The terms contained in this standard are intended to be used by available semantic models such as, but not limited to, the future ASHRAE 223P standard, Project Haystack, and Brick.

ANSI C137.9 (in development)

Excerpt from *ANSI Standards Action,* Volume 52, Number 39, page 13, September 24, 2021
https://share.ansi.org/Shared%20Documents/Standards%20Action/2021-PDFs/SAV5239.pdf
NEMA (ASC C137) (National Electrical Manufacturers Association) *New Standard*
BSR C137.9-202X, Lighting Systems - Networked Lighting Control (NLC) - System Configuration Report

Stakeholders: Producers, users, general interest.

Project Need: The standard is looking to provide a consistent, dynamic, and comparable way to communicate how Networked Lighting Control systems have been programmed after hardware installation and startup. This standard is needed to provide all stakeholders a means by which to understand how a lighting system (or portions of it) have been configured at the point-in-time the report is generated. The report will help make utility programs easier to validate and administer as well as allows a simplified review of sys...

Scope: This standard defines a generated Configuration Report providing stakeholders with the ability to quickly understand how a Networked Lighting Control (NLC) system is configured at the point in time the report is generated. The configuration report would include standardized industry nomenclature from an existing NEMA or ANSI standard. The report would be exportable to a common data format and provide the minimum required information to confirm control strategies programming, key system information, as well as energy savings.

NLC5 Technical Requirements

DLC Networked Lighting Control System Technical Requirements Version NLC5
https://www.designlights.org/our-work/networked-lighting-controls/technical-requirements/nlc5/