Better Buildings®
U.S. DEPARTMENT OF ENERGY

IoT-Upgradeable Lighting Challenge

Performance Requirements
Version: 1.0

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U.S. DEPARTMENT OF ENERGY

Table of Contents

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Overview

This is a program supported by the U.S. Department of Energy (DOE) focusing on upgradeable luminaires or retrofit kits. **This is a voluntary program**. DOE welcomes comment on anything within the draft performance targets including the overview, the requirements, the evaluation process, as well as questions to address. Please provide any feedback to: lightingchallenge@pnnl.gov.

Background

There are approximately 1 billion commercial and industrial luminaires installed in the U.S. By selecting products that meet or exceed the performance requirements of this Challenge, building owners can typically save more than 50% of the energy used for lighting on a one-for-one basis (assuming replacing traditional lighting with LED luminaire) and up to 80% with the addition of lighting control options.

Although luminaires are frequently being replaced or upgraded with LED options, few of the LED luminaires and retrofit kits sold today are equipped with advanced lighting controls or Internet of Things (IoT) capabilities. To date, only ≈1% of lighting systems are connected or IoT enabled (i.e., leveraging connectivity between lighting devices and with other systems to realize additional savings and value.).

Advanced communication technologies are enabling a paradigm shift for lighting that goes beyond lamps and luminaires communicating with each other, to systems that transmit sensor and other data to remote processors. Such data may be leveraged by various other systems, such as HVAC and plug loads, to enable other energy or non-energy benefits (e.g., asset tracking for more efficient operations or air quality monitors for healthier buildings and work environment). **Adoption of this advanced technology – with its energy-saving and operational benefits – could be accelerated if building owners were provided with easily upgradeable, cost-effective luminaires today.**

Purpose

The purpose of this Challenge is to encourage the development (by manufacturers) and adoption (by end users) of *cost-effective* luminaires and/or retrofit kits that can be upgraded to use IoT devices/sensors after installation. Following the upgrade, luminaires shall have *both* networked Luminaire-Level Lighting Controllers[1] and the ability to deliver other non-lighting or non-energy benefits.

The Challenge was developed through collaboration with building owners and operators, technical experts, manufacturers and other stakeholders. Luminaires and retrofit kits that meet or exceed the requirements of this Challenge are expected to deliver energy savings, reliable performance, improved user experience, and upgradeability for future lighting and IoT applications.

Scope

The challenge focuses on luminaires and retrofit/conversion kits for commercial and industrial applications. Successful products will meet or exceed the lighting and energy performance parameters contained herein

[1] Luminaire-level lighting controllers (LLLC) are integral to the luminaire – meaning a controller and set of sensors (often occupancy and daylight sensors) are physically located within each luminaire. Often these LLLC are networked to other luminaires or non-lighting systems.

for the same product that is not IoT upgradeable at low incremental cost (~10%). The focus areas for this Challenge are detailed in the sections that follow.

Challenge Priorities

Product Performance and Cost

In order to be competitive with same products that are not IoT upgradeable, LED luminaires and retrofit kits meeting the performance requirements of this Challenge should offer similar, or improved, lighting and energy performance as compared to the equivalent luminaire or retrofit kit that is not upgradable, and be competitive in terms of total first cost (materials and installation).

This challenge is focusing on proportional cost increase rather than a specific dollar price of the luminaire or retrofit kit. The challenge sets a price point of the lower of a $20 adder or no more than 10% higher than the same luminaire (or kit) without IoT upgradeability. This price point evaluation includes the luminaire or retrofit kit and *excludes any sensors and IoT devices.* The specific performance and cost of sensors and IoT devices is not specified in the Challenge.

Installation Cost and Simplicity

Products meeting this Challenge shall be capable of being physically installed in a similar manner and cost as the equivalent luminaire or retrofit kit that is not upgradable. When upgrading the luminaire by installing a sensor or module using an upgrade receptacle, this challenge requires that the device is attached using no special tools and that, once in place, the device is physically secure (e.g., by use of a twist and lock or other mechanism).

Connectivity

Products meeting this Challenge shall be capable of allowing an IoT device/sensor to be installed in the luminaire at any point in time following completed luminaire installation. At a minimum, the LED driver shall provide power to the IoT device/sensor. Either the IoT device or sensor shall be able to communicate (*i.e.,* to transmit/receive data) with other IoT devices/sensors, configuration devices, and/or a remote server.

Benefits of Participation

DOE will promote the Lighting Challenge and the value of IoT upgradeability to stakeholders including utilities, energy efficiency organizations, design professionals, and buildings owners and operators. Products that meet the Challenge will be recognized and promoted through a variety of communication channels including case studies, press releases, presentations/webinars, and the DOE website.

Process and Schedule

The Challenge will begin in Summer 2020 and finish in Summer 2021 according to the following schedule:

Description	Date
Draft Performance Requirements issued for comment	July 13, 2020
Comments due	August 10, 2020
Final Performance Requirements	TBD
Phase 1: Manufacturers provide Intent to Submit	September 30, 2020
Phase 2: Documentation Evaluation. Product documentation submitted to DOE.	December 20, 2020
Phase 3: Physical Evaluation. Physical samples submitted to DOE.	June 1, 2021
Phase 4: Announcement of Winners	TBD

Process

Phase 1: Manufacturers will indicate that they intend to participate by completing and submitting an Intent to Submit form.

Phase 2: Manufacturers will submit documentation demonstrating that their product(s) meet performance requirements. This information will confirm that the manufacturer has reviewed the performance requirements and is actively designing, or already marketing/selling, products that could meet the performance requirements. Products that pass the documentation evaluation phase move into Phase 3.

Phase 3: Entrants shall provide two physical units for physical evaluation. A U.S. Department of Energy (DOE) national laboratory (and/or subcontractors) will evaluate the physical units. The physical evaluation will include the installation of two different Zhaga Book 20 compliant IoT sensors / devices provided by the DOE national laboratory into the luminaire or retrofit kit. Phase 3 will also include a confidential price evaluation. Manufacturers will submit confidential pricing information which will be evaluated to determine if the luminaire or retrofit kit falls within the price criteria of the challenge. This is a pass / fail determination; the price is either within or NOT within the pricing requirements. No pricing information will be shared with the public. Finally, manufacturers of products that meet this challenge will be notified, and the successful products will be promoted as having met the requirements of the IoT-upgradeable Lighting Challenge.

Performance Requirements

I. Definitions

I. **IoT device** refers to any component plugged into an IoT receptacle on the luminaire, regardless of its actual functionality.
II. **IoT receptacle** refers to electrical and mechanical "port" in luminaire or retrofit kit that can support an IoT device or sensor mechanically and electrically connects to the driver. The IoT sensor must be exposed to the occupied space.
III. **IoT-Upgradeable** refers to a product's ability to be upgraded with an IoT sensor or device, and to be capable of transmitting luminaire data to the IoT sensor or device.
IV. **LED retrofit kits** are defined as products used to upgrade installed luminaires and that do not employ existing lamp holders, bases, or sockets to source power AND do not allow for legacy (i.e. previously existing) light sources to be capable of being physically installed, or functional, after modification of the existing luminaire is completed.
V. **Sensor module** refers to dedicated sensor(s) incorporated into a luminaire to sense motion and/or ambient lighting levels.

II. Scope

I. **This Challenge applies to LED luminaires and LED retrofit kits designed for commercial and industrial buildings.**

III. Electrical and Photometric

I. Operating voltage: 120 – 277 V / 60 Hz - combination or range containing all of these operating voltages is acceptable
II. Maximum standby power: 1W with no sensors connected
III. Driver: D4i Standard Compliant (https://www.digitalilluminationinterface.org/d4i/)
IV. Meet (but does not have to be listed) DesignLights Consortium Version 5.1 Premium (https://www.designlights.org/solid-state-lighting/qualification-requirements/technical-requirements-V5-1/v5-1-tech-req-tables-PDF/) for the following:
    i. Efficacy
    ii. Chromaticity (CCT & Duv)
    iii. Color Rendering
    iv. Minimum light output

v. Lumen maintenance
vi. Distribution
vii. Discomfort Glare
viii. Driver ISTMT
ix. Power factor
x. Total harmonic distortion
xi. Minimum warranty

V. If retrofit kit, UL 1598 C

IV. Dimming

I. The luminaire shall be dimmable.

a. The luminaire or retrofit kit shall have a dimmable LED driver

b. The LED driver shall be capable of dimming between 100% and 10% of maximum light output

V. IoT Device/Sensor Connectivity

I. An interface to connect a lighting sensor module and/or an IoT device (e.g., a receptacle, plug, or knock out) shall be provided that:

a. Complies with Zhaga Book 20 (https://www.zhagastandard.org/products.html)

and enables any of the following applications or function/capability:

b. Occupancy Sensing

c. Daylight Sensing

d. Personalized Lighting Level Control

e. IoT application

VI. Installation Materials

I. Luminaire installation materials shall include, at a minimum:

a. Step-by-step instructions to complete installation process in new or existing construction.
   i. Written instructions (required), and
   ii. Figures/photos demonstrating key steps involved (optional)
   iii. Website link to video demonstrating process (optional)
   iv. Live support from manufacturer (optional)

b. Tools/hardware required that are not included with the luminaire

II. Retrofit kit installation materials shall include, at a minimum:

a. Retrofit kit light fixture compatibility list specifying

i. Light fixture type(s) for which retrofit kit is designed, or
ii. Light fixture manufacturer(s)/model(s) for which retrofit kit is designed

b. Tools/hardware required that are not included with the retrofit kit

c. Step-by-step instructions for installation in target light fixture types
   i. Written instructions (required), and
   ii. Figures/photos demonstrating key steps involved (optional)
   iii. Website link to video demonstrating process (optional)
   iv. Live support from manufacturer (optional)

III. Configuration materials shall include, at a minimum:

a. Products *currently available* that are compatible with the luminaire or retrofit kit:
   i. IoT sensors/modules or Sensor (only) modules, as appropriate

b. List of potential IoT devices that could be installed

Product Evaluation Process

- The evaluation results of each phase will determine eligibility for participation in the next phase.
- Equipment will be provided to U.S. Department of Energy (DOE) at no cost. The manufacturer will provide all necessary materials and equipment for complete installation, set up, and commissioning. This should be the same material provided to the end user. DOE is not responsible for any damage to the equipment. DOE makes no specific guarantees to returning the equipment.
- Entries will be evaluated in order of submission and identified with a number designating the order of submission.
- Entry evaluation results for each of the phases are considered final.
- Manufacturer is defined by ownership NOT by brand.
- Entry into the challenge will close when 10 manufacturers have completed Phase 2 evaluation. Department of Energy has the right to close the entry period early if necessary.
- Manufacturers may submit and are encouraged to submit more than 1 product type across their brands, lines, and subsidiaries. However, a manufacturer can only submit 1 product per each of the 5 Challenge-applicable fixture types:
  1. troffer,
  2. suspended linear pendant,
  3. low/bay,
  4. troffer retrofit kit, and
  5. other - an open category if the fixture would not be considered in any of the 4 other fixture types.

I. **Phase 1, Intent to Submit, no evaluation is performed. Manufacturers will be informed when their intents to participate have been received.**

Manufacturers send *Intent to Submit email* declaring intent to participate to lightingchallenge@pnnl.gov. Include:

- Organization name
- Point of contact from that organization for the Challenge

- Contact information for the point of contact
- Written description of product/solution to be submitted

Phase 1 ends September 30, 2020

II. Phase 2, Documentation Evaluation, the following submitted information will be reviewed:

a. LM-79 Report from an accredited testing laboratory
   i. Efficacy
   ii. CCT
   iii. CRI (R_a and R_9) or TM 30
   iv. Total luminous flux
   v. Spacing criteria
   vi. Zonal lumen density
   vii. Luminous intensity distribution

b. .IES file

c. Lumen Maintenance / LM-80 and TM-21
   i. LM-80 test report for the LED package/module/array used within the product
   ii. ISTMT test report
   iii. IES TM-21 calculations to support lumen maintenance claim

d. Retrofit Kits: ANSI/UL 1598C certification

e. Luminaire or retrofit kit warranty statement

f. Installation instructions

g. Operation instructions, technical information on safe operation of the components and systems and complete installation instructions must be submitted.

h. Upon completion of Phase 2, Documentation Compliance evaluation, DOE will inform each manufacturer regarding the results of the assessment. Manufacturers of systems not approved to proceed to Phase 3 will be provided feedback on the primary reasons for denial of approval.

i. Entries that pass the Phase 2, Documentation Compliance will be queued for Phase 3 Physical Evaluation in order of original submission.

j. Phase 2 document submissions due by December 20, 2020

III. Phase 3-1, Physical Evaluation: Laboratory installations will be conducted to evaluate the following:

a. Provide (2) of each luminaire or retrofit kit with complete luminaire which the retrofit kit are intended for, which are in their original state from the manufacturer.

b. Clarity of installation instructions

c. Connectivity and upgradeability:
   i. IoT receptacle powers IoT device / sensor
      1. IoT device/sensor physically connects to IoT receptacle in the luminaire
      2. Luminaire sources power to connected IoT device/sensor

Phase 3-2, Price Evaluation:

a. End users have expressed a willingness to pay a marginal premium for a luminaire that is IoT Upgradeable. To demonstrate price, the Challenge is asking manufacturers to submit distributor net prices for the luminaires to lightingchallenge@pnnl.gov. The information will be treated confidentially. The challenge organizers are not purchasing any equipment, any pricing information will be evaluated solely on a comparison basis to an equivalent luminaire that is NOT IoT Upgradeable.

b. Provide distributor net pricing for an order of 25 luminaire or retrofit kits.

c. IoT-upgradeable luminaire or retrofit kit prices will be compared to an equivalent luminaire or retrofit kit that is not upgradeable. The confidential price data will be compared to determine if the IoT-upgradeable luminaire or retrofit kit price is the lower of $20 adder or is within 10% of the equivalent luminaire or retrofit kit. Equivalent is defined as a luminaire or retrofit kit that does not contain the standard-compliant driver and does not allow for upgradeability, but otherwise matches the upgradeable luminaire or retrofit kit in all other aspects.

d. If manufacturers typically sell/ ship directly with a daylight and/or occupancy sensor in the luminaire or kit, challenge-compliant luminaires or retrofit kit prices will be compared without the cost of the sensor as part of the luminaire or kit. Please itemize the cost of any sensor typically shipped with the luminaire or retrofit kit to isolate the sensor cost from the unit.

Recognition

DOE will publicly announce entries that successfully complete the physical testing and evaluations. Note: Successful compliance with the performance requirements may not be interpreted or marketed as a product endorsement on behalf of the US DOE.

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