



U.S. Department of Energy

Lighting Prize (L-Prize)

MANUFACTURING AND INSTALLATION (M&I) PHASE RULES

Issued April 3, 2024

The L-Prize® will advance the state of the art in light-emitting diode (LED) lighting, encouraging technology developers and researchers to engage in advanced lighting system development, leading to groundbreaking designs, products, and impact for all Americans.

OFFICIAL RULES: MODIFICATIONS SUMMARY

Modifications made to the rules are summarized below.

April 3, 2024	Published final requirements for Manufacturing and Installation (M&I) Phase. See Appendix E for a detailed list of changes to M&I Phase rules from the prior June 30, 2022, draft version.
June 25, 2024	<p>The following revisions were made to address questions received:</p> <ul style="list-style-type: none"> • Luminaire Track – Life Cycle Assessment: Clarified what is required to verify the LCA • Luminaire Track – Replaceable Components: Clarified what tools are considered acceptable as “conventional, readily-available tools” • Luminaire Track – Materials and Sustainability Innovation: Revised to explicitly include reduced embodied carbon as an example of innovation that can earn points in this category • Luminaire Track – U.S. Installation: Clarified that the sensor port is required for each luminaire at the installation site, except for continuous runs of linear luminaires where the sensor port is only required at one end of the run • Connected Systems Track – Energy Reporting: Clarified that energy reporting is only required of luminaires and attached devices • Connected Systems Track – Fault Detection and Diagnostics: Clarified that notification of faults should occur within 60 minutes of the fault • Connected Systems Track - Life Cycle and Sustainability Innovation: Revised to explicitly include reduced embodied carbon as an example of innovation that can earn points in this category • Connected Systems and Luminaire Tracks – U.S. Installation: Revised to no longer require construction permit documentation for the installation.
November 27, 2024	<p>The following revisions were made to address questions received:</p> <ul style="list-style-type: none"> • Appendix D: Revised to remove construction permit documentation from the Submission Documentation Checklist for both the Luminaire and Connected Systems Tracks. • Luminaire Track – U.S. Installation: Revised to specify energy code compliance documentation in the form of a COMcheck report that quantifies the lighting power density of the installed applications.

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I. PROGRAM SUMMARY

1. INTRODUCTION

The Department of Energy (DOE) Building Technologies Office's Lighting Prize ("L-Prize" or "Prize") targets commercial sector lighting, which accounts for about 56% of national lighting energy use.¹ The L-Prize competition challenges lighting innovators to develop solid-state lighting (SSL) systems with breakthrough lighting energy efficiency, quality, functionality, and sustainability. SSL technology has the potential to bring widespread deployment of lighting products with exceptional energy efficiency, connectivity, control capabilities, and visual quality that are also affordable and accessible to a wide range of businesses and consumers. Manufacturers can achieve these goals while making use of significant U.S. content, and environmental performance and circularity should be central to design and use. The L-Prize will reward innovations that move rapidly to realize these opportunities, resulting in energy, emissions, and cost savings for all American businesses and consumers.

The L-Prize will award a total of up to \$12.2 million in cash prizes across three phases. In the earlier Concept Phase, the U.S. Department of Energy (DOE) awarded \$20,000 each to four winning competitors. In the Prototype Phase, a \$2 million prize pool was split between six winners. In the Manufacturing and Installation (M&I) Phase, up to four winners will share a \$10 million prize pool (see [TABLE 1](#)). The M&I Phase includes two tracks: the **Luminaire Track** and the **Connected Systems Track**. Competitors may submit to the Luminaire Track, the Connected Systems Track, or separately to both tracks. The purpose of the separate tracks is to encourage participation by manufacturers of all types and sizes, and support standards-based interoperability between luminaires and connected systems. The phases are detailed in the section [CONTEST PHASES](#).

Contest	Winners	Prizes
Concept Phase (complete)	4 were awarded	\$20,000 per winner
Prototype Phase (complete)	6 were awarded	\$2 million pool
M&I Phase	Up to 4	\$10 million pool

Table 1: Contest Phases and Prize Information

2. BACKGROUND

DOE awarded the first L-Prize in 2011, recognizing a high-efficiency light-emitting diode (LED) replacement for the traditional 60-watt A19 incandescent bulb. Since that time, SSL technology has continued to advance and LEDs are now the predominant light source technology for new lighting installations—from streetlights to retail lighting to homes. While commercially available LED lights are now competitive with all other lighting technologies, the full technical and application potential of SSL still far exceeds most available products. Advanced interoperable lighting systems have the potential to better manage lighting energy use, integrate with other building systems, streamline maintenance and operations, and even respond to electric grid signals, increasing the value and resiliency of buildings. The current L-Prize seeks to unlock that additional potential to combine high luminaire efficacy with exceptional lighting quality, data-driven control and functionality,

¹ U.S. Energy Information Administration. Annual Energy Outlook 2022. ["How much electricity is used for lighting in the United States?"](#) Accessed June 17, 2022. Estimated based on Annual Energy Outlook data for combined commercial and outdoor lighting.

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accessibility, and sustainable design and construction for the future of illumination in commercial and institutional buildings. The L-Prize targets connected lighting technologies for commercial building applications where there is significant opportunity for innovation, energy savings, and impact. The DOE Building Technologies Office (BTO) invites lighting innovators to participate in this new competition to bring tomorrow's lighting into today.

The goal of this L-Prize is to advance the U.S. clean energy economy for next-generation LED lighting, encouraging technology developers and researchers to engage in advanced lighting system development, which in turn will lead to transformative designs, products, and impact. The challenging technical requirements are intended to stimulate creative approaches that raise the bar for efficacy, quality of light, connectivity, resilience, and life cycle environmental impact (see [FIGURE 1](#)). Currently available technologies and systems may excel in one performance area, but often at the expense of others (e.g., some excel at efficacy but at the expense of color rendition, flicker, or glare. This can have negative impacts on worker safety, productivity, or well-being). This L-Prize aims to drive creation of accessible and interoperable lighting systems that demonstrate exceptional achievement in all areas and for all American businesses and consumers.



Figure 1: The L-Prize aims to drive creation of interoperable lighting systems that demonstrate exceptional achievement across six distinct categories. Through the challenging criteria within these categories, the competition can directly influence the equity, accessibility, and resilience benefits of advanced lighting systems.

DOE estimates that LED luminaires could achieve nearly twice their current average **luminaire efficacy** through additional improvements in LED materials, light extraction, optics, luminaire design, and electronic configuration.² Tapping the potential of LED lighting to deliver the **optimal spectrum and intensity** with appropriate spatial distribution and control could further decrease lighting energy use while meeting human physiological needs and improving the occupant experience in the built environment. Systemic improvements to **connected lighting technologies** that integrate building systems can realize additional gains, delivering both energy and nonenergy benefits. Finally, approaches that support **product life cycle** improvements, such as circular design and safe end-of-life strategies, have the potential to decrease negative life cycle and carbon impacts from lighting products and systems.

Energy justice is built on the framework of environmental justice approaches and principles.³ DOE defines energy justice as "the goal of achieving equity in both the social and economic participation in the energy system, while also

² Based on current [DesignLights Consortium Solid-State Lighting Technical Requirements Version 5.1](#). See Table 2 for DLC Standard minimum efficacy of 110 lm/W for troffers. DOE [2022 Solid-State Lighting R&D Opportunities](#). See Table 2.5 for 2050 goal of 214 lm/W for luminaire efficacy.

³ K. Jenkins, "Setting energy justice apart from the crowd: Lessons from environmental and climate justice," *Energy Research & Social Science*, pp. 117-121, 2018.

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remediating social, economic, and health burdens on those disproportionately harmed by the energy system,” and acknowledges four tenets of energy justice: procedural justice, distributive justice, recognition justice, and restorative justice.⁴ In 2021, President Biden issued EO 14008 “Tackling the Climate Crisis at Home and Abroad,” which established the Justice40 Initiative (J40). This initiative directs at least 40% of the overall benefits of certain federal investments to flow to disadvantaged communities (DACs).⁵ By prioritizing energy justice and equity, J40 aims to address current and historical disparities by ensuring that benefits are effectively delivered to DACs. “Historically, low-income communities and communities of color have been disproportionately affected by pollution, extreme weather events, and other environmental impacts of fossil fuel generation. Therefore, these disadvantaged communities stand to benefit the most from access to renewable energy technologies, energy efficient housing, and low-carbon transportation options.”⁶ “A focus on energy justice and equity policies, programs, and investments is key to distributing the benefits and burdens of the energy system equitably and remediating burdens (social, economic, health-related) on those who are disproportionately harmed by the energy system, while also giving them the opportunity to influence the processes that govern the energy system and related research design, development, and deployment (RDD&D) programs.”⁷

All of the technical areas in the L-Prize carry with them an overarching commitment to driving equity, accessibility, and resilience in the design and deployment of luminaires and connected systems. Considering diversity, energy justice, and equity from the early stages of research, design, and development can support broader access to, and adoption of, advanced lighting technologies. The L-Prize includes technical or innovation criteria that support elements of energy justice and equity, accessibility to all Americans, and improved resilience to enhance health, quality of life, and economic opportunities for all communities.

3. TARGETED APPLICATIONS, SYSTEMS, AND LUMINAIRE TYPES

The L-Prize technology scope includes the luminaires, sensors, control devices, and interfaces that constitute a fully interoperable connected lighting system. The competition targets commercial sector applications in which building owners can realize significant energy savings and occupant benefits over conventional lower-performing and non-connected lighting systems. Luminaires must be appropriate for ambient lighting in commercial and institutional building interiors such as offices, healthcare facilities, educational facilities, and other settings where linear lighting predominates. Luminaires specifically designed or intended for task, accent, display, outdoor, and industrial applications (including low- and high-bay luminaires) are not eligible. Eligible Luminaire Track entries are intended to be interoperable with eligible Connected Systems Track entries, and vice versa.

4. CONTEST PHASES

The L-Prize has three distinct phases. The first two phases are complete. A competitor may participate in the third phase whether they participated in earlier phases or not. Competitor entries to each phase are

⁴ DOE Office of Energy Justice and Equity, “Justice40 Initiative Environmental Justice Fact Sheet,” 25 July 2022. [Online]. Available: https://www.energy.gov/sites/default/files/2022-07/Environmental%20Justice%20Explainer%207_25_22.pdf.

⁵ Executive Office of the President, Executive Order 14008: Tackling the Climate Crisis at Home and Abroad, Washington, DC: Executive Office of the President, 2021.

⁶ DOE Office of Energy Efficiency & Renewable Energy, “Energy Equity and Environmental Justice,” [Online]. Available: <https://www.energy.gov/eere/energy-equity-and-environmental-justice#:~:text=While%20DOE%20has%20helped%20bring,of%20electric%20vehicle%20income%20credits>. [Accessed 25 January 2024].

⁷ E. Puig-Santana, K. Johnston, K. Hickcox, “Guidance for Integrating Energy Justice and Equity in Building Technology Deployment Programs,” 27 Feb 2024. [Online]. Available: <https://www.pnnl.gov/publications/guidance-integrating-energy-justice-and-equity-building-technology-deployment-programs>

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independently evaluated without considering entries in any other phase.

1. The **Concept Phase** invited innovative concept proposals documenting a luminaire and lighting system of the future. The Concept Phase was completed in February 2022.
2. The **Prototype Phase** invited physical prototype systems, emphasizing technological innovation and challenging competitors to think outside the standard forms, materials, and price points of commercially available products. The Prototype Phase was completed in October 2023.
3. The **M&I Phase** will reward production and installation of products meeting the L-Prize technical requirements in real-world buildings. This phase will be open for 16 months (see [TABLE 2](#)). Up to four competitors earning the most points based on innovation, U.S. content, production, and installation will share an award of \$10 million.

The M&I Phase has two separate tracks: a Luminaire Track and a Connected Systems Track. Competitors may submit an entry for one track or separate entries for both tracks. DOE will evaluate each track's submissions independently.

See the [MANUFACTURING AND INSTALLATION PHASE](#) section for complete details.

5. IMPORTANT DATES

Opening Date	Deadline or Closing Date	Event
April 3, 2024	x	M&I Phase opens for submissions (open for 16 months)
	October 1, 2024	M&I Expression of Interest forms due
	April 1, 2025	M&I Phase Intent to Submit forms due
	June-July 2025	Connected Systems pre-testing
	August 5, 2025	M&I Phase submissions due (all tracks)
	February 2026 (anticipated)	M&I Phase winners announced

Table 2: L-Prize Competition Timeline and Important Due Dates

All dates are subject to change including contest openings, deadlines, and announcements. Sign up for updates at <https://www.herox.com/LPrize>.

6. CONTEST RULES

The L-Prize includes multiple innovation categories: six in the Luminaire Track and four in the Connected Systems Track. With each category, certain submission criteria may be mandatory; the Expert Reviewer Panel will award points for innovations or performance exceeding the minimum requirements. Winners must meet minimum technical performance requirements for all mandatory items listed in Figures 2 and/or 3. [FIGURE 2](#) lists mandatory minimum and points-earning requirements for the **Luminaire Track**. [FIGURE 3](#) lists mandatory

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minimum and points-earning requirements for the **Connected Systems Track**. Appendices A and B provide detailed information on all mandatory requirements and available points.

Luminaire Track Mandatory Minimum and Points-Earning Requirements

Efficacy	Quality of Light	Connectivity	Product Life Cycle	Technical Innovation	U.S. Content, Production, and Installation
✓+□ Luminaire Efficacy	✓ Light Output ✓+□ Color Rendition ✓ Chromaticity ✓ Glare Control ✓ Temporal Light Modulation (TLM, Flicker) ✓ Dimming Range ✓ Spectral Power Data (SPD) □ White-Tunable □ Visual Comfort	✓ Standards-Based Digital Driver ✓ Standards-Based Sensor Port and Connector	✓+□ Circular Design ✓ Life Cycle Assessment (LCA) ✓ Replaceable Components ✓ Labeling and Markings □ Materials and Sustainability Innovation ✓ Lumen Maintenance ✓ Chromaticity Maintenance ✓ Driver Lifetime	□ Application Efficiency □ Form Factor and Aesthetics □ Ease of Installation □ Affordability and Value Proposition □ Health and Wellbeing	✓+□ U.S. Content ✓+□ Production and Deployment Plan ✓ U.S. Installation ✓ Commercial Availability
Key ✓ = Mandatory ✓+□ = Mandatory + Points Available □ = Optional or Points Only					

Figure 2: Luminaire Track Mandatory Minimum and Points-earning Requirements.

Connected Systems Track Mandatory Minimum and Points-Earning Requirements

Connectivity	Product Life Cycle	Technical Innovation	U.S. Content, Production, and Installation
<ul style="list-style-type: none"> ✓ Standards-Based Luminaire or System Controller ✓ Technical Interoperability ✓+□ Application Interoperability ✓ Addressability ✓ Cybersecurity ✓ Energy Reporting ✓ Lighting Control Strategies ✓+□ System Resilience ✓+□ Fault Detection and Diagnostics (FDD) ✓ Standards-Based Luminaire-Level Lighting Control (LLLC) ✓+□ Grid Services Capable 	<ul style="list-style-type: none"> □ Life Cycle and Sustainability Innovation ✓ Labeling and Markings 	<ul style="list-style-type: none"> □ Ease of Installation and Use □ Compatibility and Interoperability □ Scalability □ Affordability and Value Proposition □ Health and Wellbeing 	<ul style="list-style-type: none"> □ U.S. Content ✓+□ Production and Deployment Plan ✓+□ U.S. Installation ✓ Commercial Availability

Key

- ✓ = Mandatory
- ✓+□ = Mandatory + Points Available
- = Optional or Points Only

Figure 3: Connected Systems Track Mandatory Minimum and Points-earning Requirements.

7. L-PRIZE ROLES

The following roles are referenced throughout this document.

Prize Administrator – Prize administration will be carried out by the National Renewable Energy Laboratory (NREL), which hosts the American-Made Challenges website, and the Pacific Northwest National Laboratory (PNNL), which is responsible for the technical requirements and evaluation process.

Expert Reviewer Panel – A panel of nonfederal officers will review and score entries submitted to this competition to determine whether each entry meets the L-Prize requirements detailed in this document, determine the number of points earned, and then recommend winners to the Judge. The Expert Reviewer Panel is composed of individuals who collectively are knowledgeable about lighting science, SSL technologies, engineering, energy efficiency, connected/networked lighting, installation practices, environmental sustainability, energy justice and equity, and lighting manufacturing.

Judge – The director of the Building Technologies Office within the DOE Office of Energy Efficiency (EERE) and Renewable Energy or a designee will select the winners for each phase of the L-Prize based on the evaluation criteria and results of independent and internal reviews set out in these rules.

II. CONCEPT PHASE

The Concept Phase was completed in February 2022. More information about Concept Phase winners can be found at <https://www.herox.com/LPrize/teams>.

III. PROTOTYPE PHASE

The Prototype Phase was completed in October 2023. More information about Prototype Phase winners can be found at <https://www.herox.com/LPrize/teams>.

IV. MANUFACTURING AND INSTALLATION (M&I) PHASE

The M&I Phase is the third and final phase of the L-Prize. In this phase, competitors will demonstrate real-world viability of lighting products for evaluation by the Expert Reviewer Panel, including U.S. manufacturing, and actual installation(s).

M&I Phase Prizes

- Up to 4 winners
- \$10 million prize pool

1. SUMMARY

The M&I Phase will recognize teams that are able to translate innovations inspired by the L-Prize into market availability and installation. The M&I Phase has two separate tracks: the **Luminaire Track** and the **Connected Systems Track**. Competitors may submit to the Luminaire Track, the Connected Systems Track, or separately to both tracks. DOE will evaluate each track's submissions independently. All entries must meet the minimum technical requirements and be fully commercially available and physically installed in real-world applications that demonstrate benefits ranging from energy efficiency and lighting quality to connectivity and sustainability. The M&I Phase also includes evaluation criteria unique to this phase, including U.S. manufacturing content, installation, and deployment strategy.

2. PROCESS

The M&I Phase has six steps:

- 1. Registration:** Eligible competitors must register to participate at <https://www.herox.com/LPrize> to enter a submission package. Registration does not indicate intent to enter but provides important L-Prize updates and event invitations. Early registration is strongly encouraged to receive all communications.
- 2. Expression of Interest:** The M&I Phase requires competitors to provide a completed Expression of Interest form through HeroX for each track they are considering entering, due six months after phase opening (see [TABLE 2](#) for timing).
- 3. Intent to Submit:** The M&I Phase requires competitors to provide a completed Intent to Submit form through HeroX for each track they intend to enter, due twelve months after phase opening (see [TABLE 2](#) for timing).
- 4. Submission:** The M&I Phase requires competitors to submit both technical documentation and physical working luminaires or systems for evaluation. All documentation must be submitted through HeroX. Instructions for submitting the luminaire and connected systems are provided in the Submission Instructions and Evaluation Plan documents located in the HeroX resources section.
- 5. Evaluation:** The Expert Reviewer Panel will evaluate each entry. The panel will review documentation and conduct a physical evaluation to determine whether the submitted system meets the L-Prize requirements and to calculate the score achieved. Competitors will be required to submit three (3) working products to be evaluated in the laboratory setting, and document at least one U.S. installation of the luminaires or connected system that DOE can physically evaluate. Members of the Expert Reviewer Panel and/or representatives of DOE and/or the Prize Administrator may visit the sites in person. The judging criteria are described in the [LUMINAIRE TRACK SUBMISSION EVALUATION](#) and [CONNECTED SYSTEMS TRACK SUBMISSION EVALUATION](#) sections.

6. **Announcement:** After the M&I Phase submission evaluation, the Prize Administrator will notify winners and request the necessary information (IRS W-9 form, ACH form, and Prize Acceptance form) to distribute cash prizes. The Prize Administrator will then publicly announce the winners.

3. PRIZES

The M&I Phase will offer a \$10 million prize pool, divided among up to four winners based on the number of points earned by each winner. The minimum prize amount for a winner of this phase is \$1 million. DOE will also consider program policy factors (see PROGRAM POLICY FACTORS for details) in determining winners and prize amounts and reserves the right to select fewer than four winners or any combination of winners from each track.

4. WHAT TO SUBMIT

A complete submission package for the M&I Phase must include the following:

If Submitting to Luminaire Track	If Submitting to Connected Systems Track
<ul style="list-style-type: none">• Cover page, which may be released to the public by DOE• PowerPoint summary slide, which may be released to the public by DOE• Images of luminaire, manufacturing, team, and installation, which may be released to the public by DOE• Technical documentation listed under “Materials to Submit” in Appendix A for each category topic• Completed M&I Phase Technical Performance and Scoring Form• Description of key innovations and features• Three complete working physical luminaires	<ul style="list-style-type: none">• Cover page, which may be released to the public by DOE• PowerPoint summary slide, which may be released to the public by DOE• Images of connected system components, manufacturing, team, and installation, which may be released to the public by DOE• Technical documentation listed under “Materials to Submit” in Appendix B for each category topic• Completed M&I Phase Technical Performance and Scoring Form• Description of key innovations and features• System one-line diagram• Instructions for Expert Reviewer Panel• Three complete working physical connected systems
Descriptions of each submission element follow.	

Cover page (to be made public)

Competitors must create a one-page PDF cover page with the following information:

- Submission/product title
- Short description of the luminaire or connected system
- Brief explanation of the intended market and applications
- Key team members (names, contact information, and links to LinkedIn profiles, if possible)
- Keywords that best describe your team's solution (e.g., troffer, connected, sustainable)
- City, state, and 9-digit zip code for the lead team member
- Other partners, if any, and description of partner relationship.

Competitors should not include any trade secrets or commercial information that is privileged or confidential on the cover page.

PowerPoint summary slide (to be made public)

Competitors must create a single-slide summary in PowerPoint that contains technically specific details about the submission that can be understood by a nontechnical audience. No specific template is required, but text should be readable on a standard printout and conference room projection. Competitors should not include any trade secrets or commercial information that is privileged or confidential on their summary slide.

Images of luminaire, manufacturing, team, and installation (Luminaire Track only, to be made public)

Competitors must provide a set of high-quality, high-resolution (300 dpi) images for use in promoting the L-Prize winning team(s) and innovations. The set of images must include:

- Images of the luminaire by itself at various angles
- Images of the luminaire being manufactured or assembled
- Images of the luminaire design and/or manufacturing team
- Images of the luminaire being installed at the installation site.

Images of connected systems components, manufacturing, team, and installation (Connected Systems Track only, to be made public)

Competitors must provide a set of high-quality, high-resolution (300 dpi) images for use in promoting the L-Prize winning team(s) and innovations. The set of images must include:

- Images of the connected system components, including a single image of all components, and individual images of each component
- Images of the components being manufactured or assembled, if components are manufactured or assembled by the competitor
- Images of the connected system design and/or manufacturing team
- Images of the connected system being installed at the installation site.

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Technical documentation listed in Appendix A or B (not public)

For each technical requirement and optional point, Appendices A and B list the “Materials to Submit” for each track of the M&I Phase. This required information typically will be test reports based on industry standards or product documentation or information about the installation site. In some cases, it may include written narratives such as a production and deployment plan or engineering analysis to support the competitor’s claimed innovations and/or performance.

See [APPENDICES A and B](#) for full details. [APPENDIX C](#) provides requirements for acceptable testing laboratories and reporting requirements. [APPENDIX D](#) provides a consolidated checklist of materials to submit for each track.

Completed M&I Phase Technical Performance and Scoring Form (not public)

Competitors must complete the provided M&I Phase Technical Performance and Scoring Form (available at <https://www.herox.com/LPrize/resources>) to document the expected technical performance and number of points earned for their M&I submission.

Description of key innovations and features (not public)

Competitors must provide a one-page PDF summarizing the key innovations and features of their solution they would like to highlight for DOE and the Expert Reviewer Panel.

System one-line diagram (not public) — Connected Systems Track only

Connected systems track competitors must provide a one-page PDF of a system one-line diagram (a symbolic representation of the electric power and communication system, sometimes called a single-line diagram) for their installation and for a typical system that would be laid out for a one-story small office building, including required connected lighting system components. The one-line diagram should indicate the system hierarchy and how components are connected electrically or wirelessly.

Instructions for Expert Reviewer Panel (not public) — Connected Systems Track only

Connected systems track competitors must provide detailed instructions to the Expert Reviewer Panel for how to demonstrate or implement the required connectivity capabilities and associated points earned for the system, as applicable. If instructions are not provided or cannot be followed and the Expert Reviewer Panel is unable to verify the claimed performance, then credit and/or associated points may not be given for the claimed connectivity capability. These instructions are in addition to the technical documentation required in Appendix B.

Three complete working luminaires (photos to be made public) — Luminaire Track only
<p>Luminaire Track competitors must provide three complete working luminaires: one to be installed and tested, one to be disassembled, and one to have as a backup. For linear pendant luminaires that may be installed in continuous rows, three independent 4-foot sections that function as independent luminaires must be provided.</p> <p>See the LUMINAIRE TRACK SUBMISSION EVALUATION section and the Submission Instructions and Evaluation Plan document on HeroX Resources for additional information and submission requirements.</p>
Three complete working connected systems (photos to be made public) — Connected Systems Track only
<p>Connected Systems Track competitors must provide three complete working connected systems: one to be installed and tested, one to be disassembled, and one to have as a backup.</p> <p>See the CONNECTED SYSTEMS TRACK SUBMISSION EVALUATION section and the Submission Instructions and Evaluation Plan document on HeroX Resources for additional information and submission requirements.</p>

5. LUMINAIRE TRACK SUBMISSION EVALUATION

The Expert Reviewer Panel will evaluate each M&I Phase submission. The panel will conduct both documentation review and physical evaluation to determine if the submitted luminaire meets the L-Prize requirements and to calculate the total score. The Expert Reviewer Panel will install at least one of the submitted luminaires in a ceiling in a laboratory setting to evaluate selected capabilities of the luminaire.

See the Luminaire Track Submission Instructions and Evaluation Plan document located at <https://www.herox.com/LPrize/resources> for further information about what the competitor must provide and the specific testing and evaluation that will be implemented on the luminaire. All instructions must be followed and criteria in the Submission Instructions and Evaluation Plan document must be met.

The Expert Reviewer Panel will also review the U.S. Content, Production, and Installation documentation to verify that minimum requirements are met and will score any additional points for U.S. content, production, and deployment. The final assembly of the luminaire (including integral subsystem components) must take place in the United States. See [APPENDIX A](#) for further details.

Expert Reviewer Panel Scoring Approach: The Expert Reviewer Panel will score each entry based on the number of points available for the requirements listed in [TABLE 3](#) with additional details provided in [APPENDIX A](#). In scoring each entry, the Expert Reviewer Panel will use the following approach:

- The Expert Reviewer Panel will review the Technical Performance and Scoring Form and technical documentation submitted by the competitor and conduct a physical evaluation (where applicable) to determine the number of points earned for Luminaire Efficacy, Color Rendition, and Circular Design.
- The Expert Reviewer Panel will review the technical documentation and narratives submitted by the competitor and conduct a physical evaluation (where applicable) to score the topics of Visual Comfort, Materials and Sustainability Innovation, Application Efficiency, Form Factor and Aesthetics, Ease of Installation, Affordability and Value Proposition, U.S. Content, and Production and Deployment Plan.

16 • The total score for the submission will be the total number of points accrued for all review

Appendix E: Changes to M&I Phase Rules from Prior Published Draft Version

criteria.

Interviews: The Prize Administrator, at their sole discretion, may request interviews of selected M&I Phase competitors. The interviews would be held before the winners are announced and would serve to help clarify questions DOE may have. Participating in interviews is not required and being contacted for an interview is not an indication of winning.

Final Determination: The Judge's final determination of M&I Phase winners will take into account the highest total scores using the Luminaire Track Minimum Requirements and Points Summary shown in [TABLE 3](#), interview findings (if applicable), and program policy factors listed in the

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ADDITIONAL TERMS AND CONDITIONS: [PROGRAM POLICY FACTORS](#) section.

M&I Phase, Luminaire Track: Minimum Requirements and Points Summary				
See APPENDICES A and C for details of the Minimum Requirements and Possible Points				
Category	Topic	Minimum Requirement(s)	Possible Points per Topic	Total Maximum Points per Category
Efficacy	Luminaire Efficacy	≥ 150 lm/W	Up to 10 pts. for performance above 150 lm/W	10 pts.
Quality of Light	Light Output	$> 2,000$ lm	n/a	15 pts.
	Color Rendition	Preference rating of P2, fidelity rating of F3	5 pts. for improved preference rating of P1	
	Chromaticity	4000 K, Duv between -0.006 and 0.002	n/a	
	Glare Control	UGR ≤ 22 or technical justification	n/a	
	Temporal Light Modulation (TLM, Flicker)	Fundamental frequency > 90 Hz, SVM ≤ 0.4	n/a	
	Dimming Range	Dims to 5% or lower	n/a	
	Spectral Power Data (SPD)	SPD in ≤ 5 -nm increments	n/a	
	White-Tunable	If product is white tunable, must	n/a	

Appendix E: Changes to M&I Phase Rules from Prior Published Draft Version

M&I Phase, Luminaire Track: Minimum Requirements and Points Summary				
See APPENDICES A and C for details of the Minimum Requirements and Possible Points				
Category	Topic	Minimum Requirement(s)	Possible Points per Topic	Total Maximum Points per Category
		be tested at 4000 K		
	Visual Comfort	n/a	Up to 10 points scored by Expert Reviewer Panel	
Connectivity	Standards-Based Digital Driver	Uses D4i™-compliant smart driver	n/a	n/a
	Standards-Based Sensor Port and Connector	Contains Zhaga Book 20-compliant sensor port and connector	n/a	
Product Life Cycle	Circular Design	TM66 CEAM-Make ≥ 2	5 pts. for TM66 CEAM-Make ≥ 2.5; additional 5 pts. for TM66 CEAM-Make ≥ 3 (10 pts. total)	20 pts.
	Life Cycle Assessment (LCA)	LCA and EPD required	n/a	
	Replaceable Components	Light sources and drivers must be replaceable	n/a	
	Labeling and Markings	Labeling or markings with service, disassembly, and end-of-life info required	n/a	
	Materials and Sustainability Innovation	n/a	Up to 10 pts. scored by the Expert Reviewer Panel	
	Lumen Maintenance	L ₉₀ ≥ 36,000 hrs and L ₇₀ ≥ 50,000 hrs	n/a	
	Chromaticity Maintenance	≤ 0.002 at 6,000 hrs	n/a	
	Driver Lifetime	≥ 50,000 hrs	n/a	
Technical Innovation	Application Efficiency	n/a	Up to 10 pts. scored by the Expert Reviewer Panel	50 pts.
	Form Factor and Aesthetics	n/a	Up to 10 pts. scored by the Expert Reviewer Panel	
	Ease of Installation	n/a	Up to 10 pts. scored by the Expert Reviewer Panel	
	Affordability and Value Proposition	n/a	Up to 10 pts. scored by the Expert Reviewer Panel	
	Health and Wellbeing	n/a	Up to 10 pts. scored by the Expert Reviewer Panel	
U.S. Content, Production, and Installation	U.S. Content	U.S. assembly required	Up to 15 pts. for additional U.S. content scored by Expert Reviewer Panel	30 pts.
	Production and Deployment Plan	Documented production and deployment plan must be provided	Up to 15 pts. based on quality of plan scored by Expert Reviewer Panel	
	U.S. Installation	At least 1 U.S.-based project installation	n/a	
	Commercial Availability	Luminaire must be fully certified and commercially available	n/a	

Table 3: M&I Phase, Luminaire Track—Minimum Requirements and Points Summary

6. CONNECTED SYSTEMS TRACK SUBMISSION EVALUATION

The Expert Reviewer Panel will evaluate each M&I Phase connected system submission. The panel will conduct both documentation review and physical evaluation to determine if the submitted system meets the L-Prize requirements and to calculate the total score.

For the physical evaluation, each connected system will be evaluated on a grid of four 2' x 2' troffer luminaires provided by the competitor and installed in a laboratory setting. The luminaires must be 2' x 2' troffers with D4i™-compliant drivers and Zhaga Book 20-compliant sensor ports. See the Connected Systems Submission Instructions and Evaluation Plan document located at <https://www.herox.com/LPrize/resources> for further information about what the competitor must provide and the specific testing and evaluation that will be

Appendix E: Changes to M&I Phase Rules from Prior Published Draft Version

implemented on the connected system. All instructions must be followed, and tests detailed in the Submission Instructions and Evaluation Plan document must be passed.

A connected systems pre-testing period will occur prior to the submission due date. During that period the competitors will remotely test the connectivity of their application programming interface (API) and OpenADR VEN/VTN with DOE test protocols. Competitors will later be required to send up to two representatives to the laboratory evaluation site to assist in installing and configuring the submitted system and in debugging any issues that occur during testing. See the Submission Instructions and Evaluation Plan for more information.

Expert Reviewer Panel Scoring Approach: The Expert Reviewer Panel will score each entry based on the number of points available for the requirements listed in [TABLE 4](#) with additional details provided in [APPENDIX B](#). In scoring each entry, the Expert Reviewer Panel will use the following approach:

- The Expert Reviewer Panel will review the Technical Performance and Scoring Form and technical documentation submitted by the competitor and conduct a physical evaluation (where applicable) to determine the number of points earned for the System Resilience, Fault Detection and Diagnostics (FDD), and Grid Services Capable topics.
- The Expert Reviewer Panel will review the technical documentation and narratives submitted by the competitor, conduct a physical evaluation (where applicable), and score the Life Cycle and Sustainability Innovation, Ease of Installation and Use, Compatibility and Interoperability, Scalability, Affordability and Value Proposition, U.S. Content, and Production and Deployment Plan topics.
- The total score achieved for the submission will be the total number of points accrued for all review criteria.

Interviews: The Prize Administrator, at its sole discretion, may request interviews of selected M&I Phase competitors. The interviews would be held before the winners are announced and would serve to help clarify questions DOE may have. Participating in interviews is not required and being contacted for an interview is not an indication of winning.

Final Determination: The Judge's final determination of M&I Phase winners will take into account the highest total scores using the Connected Systems Track Minimum Requirements and Points Summary shown in [TABLE 4](#), interview findings (if applicable), and program policy factors listed in the

ADDITIONAL TERMS AND CONDITIONS: [PROGRAM POLICY FACTORS](#) section.

M&I Phase, Connected Systems Track: Minimum Requirements and Points Summary See APPENDICES B and C for details of each Minimum Requirement and Possible Points				
Category	Topic	Minimum Requirement(s)	Possible Points per Topic	Total Maximum Points per Category
Connectivity	Standards-Based Luminaire or System Controller	Interoperable with D4i™ drivers and/or sensors	n/a	60 pts.
	Technical Interoperability	Complies with industry standard specification for basic network connectivity	n/a	
	Application Interoperability	Access to zone, occupancy, faults, energy data	Up to 15 pts. if BACnet certified to support HVAC integration	
	Addressability	All luminaires and devices are addressable	n/a	
	Cybersecurity	Third-party certification	n/a	
	Energy Reporting	Energy reporting capability of luminaires and attached devices required	n/a	
	Lighting Control Strategies	Task, schedule, occupancy, daylight control required	n/a	
	System Resilience	Maintains control after temporary loss of connection to network or power	15 pts. for maintaining control after loss of connection to gateway	
	Fault Detection and Diagnostics (FDD)	Reports basic system faults	Up to 15 pts. for advanced, predictive FDD capabilities	
	Standards-Based Luminaire Level Lighting Control (LLC)	D4i sensing/communication module per luminaire	n/a	
	Grid Services Capable	OpenADR 3.0 demand response required	Up to 15 pts. for advanced grid services capabilities using OpenADR 3.0	
Product Life Cycle	Life Cycle and Sustainability Innovation	n/a	Up to 10 pts. scored by the Expert Reviewer Panel	10 pts.
	Labeling and Markings	Labeling or markings with service, disassembly, end-of-life info required	n/a	
Technical Innovation	Ease of Installation and Use	n/a	Up to 10 pts. scored by the Expert Reviewer Panel	50 pts.
	Compatibility and Interoperability	n/a	Up to 10 pts. scored by the Expert Reviewer Panel	
	Scalability	n/a	Up to 10 pts. scored by the Expert Reviewer Panel	
	Affordability and Value Proposition	n/a	Up to 10 pts. scored by the Expert Reviewer Panel	
	Health and Wellbeing	n/a	Up to 10 pts. scored by the Expert Reviewer Panel	
U.S. Content, Production, and Installation	U.S. Content	n/a	Up to 15 pts. for documented U.S. content scored by Expert Reviewer Panel	45 pts.
	Production and Deployment Plan	Documented production and deployment plan must be provided	Up to 15 pts. based on quality of plan scored by Expert Reviewer Panel	
	U.S. Installation	At least 1 U.S.-based project installation	15 pts. for lighting + HVAC integration at installation site	
	Commercial Availability	Connected system must be fully certified and commercially available	n/a	

V. ELIGIBILITY REQUIREMENTS

1. COMPETITOR ELIGIBILITY

In addition to the minimum requirements outlined for each phase and track, all L-Prize competitors must comply with the eligibility requirements below. The registered competitor is the individual or entity that registers to compete on the HeroX website. Eligibility is subject to verification before prizes are awarded.

- Private entities must be incorporated in and maintain a primary place of business in the United States.
- Academic and nonfederal government entities must be based in the United States.
- Individuals applying as themselves, rather than as a representative of a business entity, must be U.S. citizens or permanent residents of the United States.
- Individuals who worked at DOE (federal employees or support service contractors) within six months prior to the submission deadline of any contest are not eligible to participate in any prize contests in this program.
- Non-DOE federal entities and federal employees are not eligible to win any prize contests in this program.
- Employees of an organization that cosponsors this program with DOE are not eligible to participate in any prize contests in this program.
- NREL and PNNL employees directly involved in administration of this prize are not eligible to participate in any prize contest in this program; however, other national laboratory employees including laboratory researchers and NREL and PNNL employees not directly involved in administration of this prize may participate. They can also win a prize contest, provided they are not competing in their official capacity.
- Entities and individuals publicly banned from doing business with the United States government such as entities and individuals debarred, suspended, or otherwise excluded from or ineligible to participate in federal programs are not eligible to compete. Individuals participating in a foreign government talent recruitment program⁸ sponsored by a country of risk⁹ and teams that include such individuals are not eligible to compete.

⁸ A Foreign Government-Sponsored Talent Recruitment Program is defined as an effort directly or indirectly organized, managed, or funded by a foreign government, or a foreign government instrumentality or entity, to recruit science and technology professionals or students (regardless of citizenship or national origin, or whether having a full-time or part-time position). Some foreign government-sponsored talent recruitment programs operate with the intent to import or otherwise acquire from abroad, sometimes through illicit means, proprietary technology or software, unpublished data and methods, and intellectual property to further the military modernization goals and/or economic goals of a foreign government. Many, but not all, programs aim to incentivize the targeted individual to relocate physically to the foreign state for the above purpose. Some programs allow for or encourage continued employment at United States research facilities or receipt of federal research funds while concurrently working at and/or receiving compensation from a foreign institution, and some direct participants not to disclose their participation to U.S. entities. Compensation could take many forms including cash, research funding, complimentary foreign travel, honorific titles, career advancement opportunities, promised future compensation, or other types of remuneration or consideration, including in-kind compensation.

⁹ DOE has designated the following countries as foreign countries of risk: Iran, North Korea, Russia, and China. This list is subject to change.

- Entities owned by, controlled by, or subject to the jurisdiction or direction of a government of a country of risk are not eligible to compete.
- To be eligible, an individual authorized to represent the competitor team must agree to and sign the following statement upon registration with HeroX:

I am providing this submission package as part of my participation in this prize. I understand that the information contained in this submission will be relied upon by the federal government to determine whether to issue a prize to the named competitor. I certify under penalty of perjury that the named competitor meets the eligibility requirements for this prize competition and complies with all other rules contained in the Official Rules document. I further represent that the information contained in the submission is true and contains no misrepresentations. I understand false statements or misrepresentations to the federal government may result in civil and/or criminal penalties under 18 U.S.C. § 1001 and § 287 and 31 U.S.C. §§ 3729-3733 and 3801-3812.

2. PROGRAM GOAL ELIGIBILITY REQUIREMENTS

Only submissions relevant to the goals of this program are eligible to compete. DOE will review all submissions to ensure that the following statements are true:

- The solution realizes exceptional performance in lighting energy efficiency, lighting quality, data-driven lighting system operation, and sustainable product life cycle considerations.
- The lighting system solution is appropriate for providing ambient lighting in commercial sector building interiors. The luminaires are not specifically intended for task, accent, display, outdoor, or industrial applications.
- The solution represents an innovation that will move the industry beyond its current state.
- The solution is not dependent on new, pending, or proposed federal, state, or local government legislation, resolutions, appropriations, measures, or policies.
- The solution does not involve the lobbying of any federal, state, or local government office.
- The solution is based on fundamental technical principles and is consistent with a basic understanding of the U.S. market economy.

If any of these statements are not true, the contest submission will not be scored or considered for a prize.

APPENDIX A: Luminaire Track Technical Requirements

The L-Prize Luminaire Track technical requirements are organized into six categories: efficacy; quality of light; connectivity; product life cycle; technical innovation; and U.S. content, production, and installation. Each technical requirement in this appendix includes:

- Definition of the requirement
- Description of the minimum requirement
- Description of the points that may be earned, if any
- Description of the method of evaluation
- Materials that competitors must submit for each phase to support each requirement
- Supplemental guidance as required
- Referenced documents, standards, or helpful resources.

A summary of these requirements and available points can be found in [TABLE 3](#).

1. Efficacy Requirements

Luminaire Efficacy	The total emitted luminous flux from the luminaire divided by the total source electrical input power
Minimum Requirement(s) The initial luminous efficacy of each luminaire must be ≥ 150 lumens per watt.	Possible Points Two points (+2) will be awarded for each additional increment of 10 lumens per watt above 150 up to a maximum of 10 points. ≥ 160 lumens per watt = 2 additional points ≥ 170 lumens per watt = 4 additional points ≥ 180 lumens per watt = 6 additional points ≥ 190 lumens per watt = 8 additional points ≥ 200 lumens per watt = 10 additional points
Method of Evaluation For luminaires with integral power supplies that accept AC at input: The Expert Reviewer Panel will review the submitted ANSI/IES LM-79 test report(s) to verify the efficacy of the luminaire. For luminaires/systems with remote power supplies including low-voltage DC and Power over Ethernet (PoE) systems: The Expert Reviewer Panel will review the submitted ANSI/IES LM-79 test report(s) and remote power supply testing report to verify the efficacy of the luminaire. The efficacy of the luminaire from the LM-79 test will be multiplied by the efficiency of the remote power supply that accepts the AC line-voltage input from a building electrical system. The resulting efficacy value will be used as the actual efficacy of the competitor's submittal. See Supplemental Testing Guidance for more information.	
Materials to Submit by Competitor (M&I Phase) For luminaires with integral power supplies that accept AC at input: <ul style="list-style-type: none"> <input type="checkbox"/> ANSI/IES LM-79 test report at 100% light output For luminaires with remote power supplies including low-voltage DC and PoE systems: <ul style="list-style-type: none"> <input type="checkbox"/> ANSI/IES LM-79 test report at 100% light output <input type="checkbox"/> Power supply testing report 	
Supplemental Testing Guidance For luminaires/systems with remote power supplies including low-voltage DC and PoE systems, the luminaire must be LM-79 tested at the rated DC input voltage to the luminaire without the remote power supply. The resulting efficacy from this LM-79 test will be multiplied by the efficiency of a remote power supply for the system assuming $50\% \pm 5\%$ loading of that power supply. A power supply testing report for a recommended power supply that would be installed with the system must be provided. This recommended power supply should be representative of a power supply that would be installed in most typical installations. The testing report may be based on benchtop testing (measurements performed by a manufacturer that are not from an accredited testing lab); however, DOE may verify the submitted testing report performance values through its own laboratory testing. The following values must be included in the power supply testing report at (1) the maximum rated power load, (2) $75\% \pm 5\%$ of maximum load, (3) $50\% \pm 5\%$ of maximum load, and (4) $25\% \pm 5\%$ of maximum load: <ul style="list-style-type: none"> • Input power, shown to the nearest hundredth of a watt • DC output power, shown to the nearest hundredth of a watt • Electrical efficiency (power output divided by power consumed), shown as a percentage to two decimal places • Power factor, shown to three significant digits 	

APPENDIX A: Luminaire Track Technical Requirements

- THD of the current waveform as a percentage, shown to one decimal place.

Example testing report:

Manufacturer Name		Model Number		AC Input Voltage Range (V)		DC Output Voltage Range (V)	
ABC Corp.		ABC123		120–277 V		48 V	
Input Voltage (V)	Output Power Range (W)	Loading Percentage	Input Power (W)	DC Output Power (W)	Electrical Efficiency (%)	Power Factor	THD (current)
277	30–300	100%	315.19	300.00	95.18%	0.932	5.1%
		75%	241.65	225.00	93.11%	0.928	4.1%
		50%	164.74	150.00	91.05%	0.911	4.0%
		25%	87.75	75.00	85.47%	0.908	3.8%

Using this example testing report, if an LM-79 test of the luminaire showed an efficacy of 179 lm/W, then DOE would consider the actual efficacy of the competitor's submittal to be $179 \times 91.05\% = 163 \text{ lm/W}$.

Referenced Documents

- [ANSI/IES LM-79-19: Optical and Electrical Measurements of Solid-State Lighting Products](#)

2. Quality of Light Requirements

Light Output		The luminous flux output by the luminaire	
Minimum Requirement(s) The initial luminous flux must be > 2,000 lumens		Possible Points n/a	
Method of Evaluation The Expert Reviewer Panel will review the submitted ANSI/IES LM-79 test report(s) to confirm the light output.			
Materials to Submit by Competitor (M&I Phase) <div><input type="checkbox"/> ANSI/IES LM-79 test report at 100% light output</div>			
Supplemental Testing Guidance n/a			
Referenced Documents <ul style="list-style-type: none">ANSI/IES LM-79-19: Optical and Electrical Measurements of Solid-State Lighting Products			

Color Rendition		How a luminaire makes the color of an object appear to human eyes and how well subtle variations in color shades are revealed
Minimum Requirement(s) The color rendition performance must meet a preference rating of P2 and fidelity rating of F3 in accordance with ANSI/IES TM-30-20, Annex E. Rf ≥ 85; Rf,h1 ≥ 85; Rcs,h1 ≥ -7%; Rg ≥ 92		Possible Points Five points (+5) will be awarded for a preference rating of P1 and fidelity rating of F3. Rf ≥ 85; Rf,h1 ≥ 85; Rcs,h1 ≥ -1%; Rg ≥ 95
Method of Evaluation The Expert Reviewer Panel will review the submitted ANSI/IES LM-79 test report(s) to confirm the color rendering performance. The .SPDX data will also be evaluated to produce and check color rendering performance. The Rf; Rf,h1; Rcs,h1; and Rg values shown in the LM-79 test report should match those produced from the .SPDX data.		
Materials to Submit by Competitor (M&I Phase) <ul style="list-style-type: none"><input type="checkbox"/> ANSI/IES LM-79 test report at 100% light output<input type="checkbox"/> Full ANSI/IES TM-30 report as specified in TM-30 Annex E<input type="checkbox"/> .SPDX file in accordance with IES TM-27-20		
Supplemental Testing Guidance n/a		
Referenced Documents <ul style="list-style-type: none">• ANSI/IES LM-79-19: Optical and Electrical Measurements of Solid-State Lighting Products• ANSI/IES TM-30-20: IES Method for Evaluating Light Source Color Rendition• ANSI/IES TM-27-20: IES Standard Format for the Electronic Transfer of Spectral Data		

Chromaticity	The quality of a color, independent of brightness	
Minimum Requirement(s) The nominal correlated color temperature (CCT) must be 4000 K as defined in ANSI C78.377-2017. The Duv must be between -0.006 and +0.002 as defined in ANSI C78.377-2017. LEDs shall be binned and selected such that any sample would result in a Duv within -0.006 and +0.002.	Possible Points n/a	

APPENDIX A: Luminaire Track Technical Requirements

Method of Evaluation
The Expert Reviewer Panel will review the submitted ANSI/IES LM-79 test report(s) to confirm the CCT and chromaticity coordinates.
Materials to Submit by Competitor (M&I Phase)
<input type="checkbox"/> ANSI/IES LM-79 test report at 100% light output
Supplemental Testing Guidance
n/a
Referenced Documents
<ul style="list-style-type: none"> • ANSI/IES LM-79-19: Optical and Electrical Measurements of Solid-State Lighting Products • ANSI C78.377-2017: Electric Lamps - Specifications for The Chromaticity of Solid-State Lighting Products

Glare Control		The ability of the luminaire to limit discomfort glare. Discomfort from glare can cause annoyance, distraction, or discomfort but does not necessarily impair the visibility of objects.										
Minimum Requirement(s) Every unit in the test sample must have a unified glare rating (UGR) ≤ 22 , per the method of evaluation described below. If the UGR ≤ 22 minimum requirement is not met, a technical justification reviewed by the Expert Reviewer Panel is determined to be acceptable for minimum glare control performance.		Possible Points n/a										
Method of Evaluation The CIE 190:2010 Calculation and Presentation of Unified Glare Rating (UGR) for Indoor Lighting Luminaires is a method of predicting glare at the luminaire level, by assessing the luminaire in a pre-determined standardized interior room environment. Luminaires will be assessed using CIE 190:2010 and the tabular method described in section 4.3. Tables must have $\geq 90\%$ of the tabular values meeting the UGR criteria (≤ 22 UGR) to meet the minimum L-Prize requirement. The CIE 190:2010 method defines standardized rooms and standardized lighting layouts to allow the industry to compare and estimate the glare potential of luminaires in a set of predefined room applications. The UGR methodology does not separate the room from the luminaire, so it is always important to take the room into consideration when making a comparison between luminaires. Background luminance (the room) and luminaire location (the layout) have the biggest impact on UGR (more than the inherent features of the luminaire). The resulting UGR values from a CIE 190:2010 based analysis are applicable to the predefined standardized spaces. The same luminaire applied in a different space or real-world application, with different dimensions, higher or lower reflectances, and/or different luminaire layouts or spacing may have different UGR results than from the CIE 190:2010 standardized application.												
<u>CIE 190:2010 Method</u> The Expert Reviewer Panel will check that the .IES file matches the submitted ANSI/IES LM-79 report, assess the competitor’s documented determination of luminous area contained within the .IES file for compliance with ANSI/IES LM-63, and calculate a corrected CIE 190:2010 UGR table from the submitted .IES file using Photometric Toolbox® version 2.9 or newer to confirm the submitted UGR score. The corrected UGR values resulting from the Photometric Toolbox calculation using the standard tabular method conditions listed in CIE 190:2010 section 4.2 will be used to assess if the requirement of ≤ 22 UGR has been met.												
<table><tr><th>UGR</th><th>Discomfort Glare Criterion</th></tr><tr><td>≤ 19 +/- 3</td><td>Just acceptable</td></tr><tr><td>≤ 16 +/- 3</td><td>Perceptible</td></tr><tr><td>≤ 13 +/- 3</td><td>Just perceptible</td></tr><tr><td>≤ 10 +/- 3</td><td>Imperceptible</td></tr></table>			UGR	Discomfort Glare Criterion	≤ 19 +/- 3	Just acceptable	≤ 16 +/- 3	Perceptible	≤ 13 +/- 3	Just perceptible	≤ 10 +/- 3	Imperceptible
UGR	Discomfort Glare Criterion											
≤ 19 +/- 3	Just acceptable											
≤ 16 +/- 3	Perceptible											
≤ 13 +/- 3	Just perceptible											
≤ 10 +/- 3	Imperceptible											
See Supplemental Testing Guidance for important additional information about this requirement.												
<u>Alternative Method Using Technical Justification</u> If the UGR ≤ 22 minimum requirement is not met, competitors may submit a written technical justification of up to two pages to be reviewed by the Expert Reviewer Panel. The Technical Justification must include the following information: <ul style="list-style-type: none">• UGR calculation results• Discussion of why the luminaire does not meet the UGR ≤ 22 minimum requirement• Discussion with supporting data and analysis to show that the luminaire has excellent glare control commensurate with the UGR ≤ 22 requirement in the standardized rooms prescribed in CIE 190:2010 The Expert Reviewer Panel will make a determination as to if the technical justification is acceptable in meeting the Glare Control minimum requirement.												
Materials to Submit by Competitor (M&I Phase) <ul style="list-style-type: none"><input type="checkbox"/> ANSI/IES LM-79 test report at 100% light output<input type="checkbox"/> .IES file in accordance with ANSI/IES LM-63<input type="checkbox"/> Documented determination of luminous area based on guidance from LM-63 and DLC<input type="checkbox"/> Tabular method corrected UGR table using values established in CIE 190:2010												
Supplemental Guidance <ul style="list-style-type: none">• The requirement is meant to ensure that luminaires do not achieve high efficacies at the expense of increased likelihood of discomfort glare.												

APPENDIX A: Luminaire Track Technical Requirements

<ul style="list-style-type: none"> Competitors should follow ANSI/IES LM-63-19 in determining this luminous area and are required to submit written documentation outlining and illustrating how the luminous area of the luminaire was determined. The Expert Reviewer Panel will assess the submitted luminous area determination and check that it complies with LM-63. DOE will accept luminous area determinations that appear close to the Expert Reviewer Panel's own determination based on the submitted product information. DOE may follow up with competitors when there appears to be a significant discrepancy between a competitor's determination and the Expert Reviewer Panel's determination. Competitors are recommended to select the most conservative (smallest) estimation of luminous area using LM-63. The luminous opening cannot be larger than the luminaire size. UGR is undefined for luminaires with 100% uplight (indirect luminaires). However, as they do not produce discomfort glare, these luminaires will be exempt from the UGR requirement. For linear ambient products with both uplight and downlight, the luminous area should encompass the luminous openings contributing to the downlight portion of the light output. UGR is undefined for luminaires that are not within the source size limits defined in CIE 190:2010. UGR is not applicable to luminous ceilings. UGR is not applicable for point sources. UGR cannot be computed for very thin (pencil-like) beam patterns pointing straight down.
Referenced Documents <ul style="list-style-type: none"> ANSI/IES LM-79-19: Optical and Electrical Measurements of Solid-State Lighting Products ANSI/IES LM-63-19: IES Standard File Format for the Electronic Transfer of Photometric Data and Related Information CIE 190:2010: Calculation and Presentation of Unified Glare Rating Tables for Indoor Lighting Luminaires CIE 232:2019: Discomfort Caused by Glare from Luminaires with a Non-Uniform Source Luminance Photometric Toolbox V2.9 https://www.designlights.org/wp-content/uploads/2021/02/DLC_UGR-Fact-Sheet.pdf

Temporal Light Modulation (TLM, aka “flicker” waveform)	TLM is the light modulation (stimulus) that may produce unwanted visual or nonvisual responses. TLM should minimize undesired visual responses of light by (direct) flicker, the stroboscopic effect, and the phantom array effect.
Minimum Requirement(s) Every unit in the test sample must exhibit a fundamental TLM frequency >90 Hz and a stroboscopic effect visibility measure (SVM) ≤0.4 at dimming levels of 100%, 50%, and the minimum dimmed light output. Pulse-width modulation (PWM) dimming is not permitted at fundamental TLM frequencies below 20 kHz.	Possible Points n/a
Method of Evaluation The Expert Reviewer Panel will review the submitted ANSI/IES LM-90-20 testing reports at 100%, 50%, and the minimum dimmed light output.	
Materials to Submit by Competitor (M&I Phase) <ul style="list-style-type: none"> <input type="checkbox"/> ANSI/IES LM-90 test report with documentation of fundamental frequency at 100% light output <input type="checkbox"/> ANSI/IES LM-90 test report with documentation of fundamental frequency at 50% light output <input type="checkbox"/> ANSI/IES LM-90 test report with documentation of fundamental frequency at minimum dimmed light output 	
Supplemental Testing Guidance The minimum dimmed light output is the minimum dimming level claimed by the competitor and listed in the product literature. It should be the same minimum dimming level claimed by the manufacturer for the Dimming Range requirement.	
Referenced Documents <ul style="list-style-type: none"> ANSI/IES LM-90-20: Measuring Luminous Flux Waveforms for Use in Temporal Light Artifact (TLA) Calculations 	

Dimming Range	The range over which it is possible to vary the intensity of the light output of a lamp or luminaire from a maximum to a minimum with stable performance
Minimum Requirement(s) Luminaire dimming range must extend from maximum lumen output (100%) to a minimum lumen output value that is ≤5% of maximum lumen output. Dimming between minimum and maximum output points must be continuous. The change of chromaticity over the dimming range must be ≤0.004, calculated as the distance between coordinate pairs on the CIE 1976 (u',v') diagram.	Possible Points n/a
Method of Evaluation The Expert Reviewer Panel will review the submitted ANSI/IES LM-79 testing reports at 100% light output and at the minimum dimmed light output.	
Materials to Submit by Competitor (M&I Phase) <ul style="list-style-type: none"> <input type="checkbox"/> ANSI/IES LM-79 test report at 100% light output 	

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<input type="checkbox"/> ANSI/IES LM-79 test report at the minimum dimmed light output
Supplemental Testing Guidance The minimum dimmed light output is the minimum dimming level claimed by the competitor and listed in the product literature.
Referenced Documents <ul style="list-style-type: none"> ANSI/IES LM-79-19: Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products

Spectral Power Data	Data that represents the spectral power distribution of the luminaire	
Minimum Requirement(s) Spectral power distribution (SPD) data must be provided in ANSI/IES TM-27-20 format. The spectral data must be reported for 380–780 nm in ≤5 nm increments.	Possible Points n/a	
Method of Evaluation The Expert Reviewer Panel will check that the competitor has provided files in compliance with the requirements.		
Materials to Submit by Competitor (M&I Phase) <input type="checkbox"/> .SPDX file in accordance with ANSI/IES TM-27-20		
Supplemental Testing Guidance n/a		
Referenced Documents <ul style="list-style-type: none"> ANSI/IES LM-79-19: Optical and Electrical Measurements of Solid-State Lighting Products ANSI/IES TM-27-20: IES Standard Format for the Electronic Transfer of Spectral Data 		

White-Tunable	The capability to control the color temperature of the luminaire	
Minimum Requirement(s) Luminaires with white-tuning capability must be evaluated at 4000 K. All submitted test results must be at 4000K and include the type of control and setting to achieve 4000 K.	Possible Points n/a	
Method of Evaluation The Expert Reviewer Panel will review the submitted test reports for Efficacy and Quality of Light requirements to verify that the test reports are at 4000K and that at least one test report includes the control type and settings to achieve 4000 K operation.		
Materials to Submit by Competitor (M&I Phase) <input type="checkbox"/> n/a		
Supplemental Testing Guidance <ul style="list-style-type: none"> n/a 		
Referenced Documents <ul style="list-style-type: none"> n/a 		

Visual Comfort	A subjective measure of the visual comfort provided by the luminaire including factors such as light distribution and glare	
Minimum Requirement(s) n/a	Possible Points Up to ten points (+10) will be awarded for visual comfort as scored by the Expert Reviewer Panel.	
Method of Evaluation The Expert Reviewer Panel will observe the luminaire in a laboratory setting and may also observe the luminaire at the installation site(s) and consider luminaire distribution data in scoring the scoring statement.		
The Expert Reviewer Panel will score the following statement: The luminaire is likely to provide excellent visual comfort in common commercial building applications when including factors such as light distribution and glare performance.		Scoring Approach: <u>Scored 0 to 10</u> 0 = strongly disagree or no submission 2 = disagree 4 = slightly disagree 6 = slightly agree 8 = agree 10 = strongly agree
Materials to Submit by Competitor (M&I Phase) <input type="checkbox"/> n/a		
Supplemental Testing Guidance n/a		
Referenced Documents <ul style="list-style-type: none"> n/a 		

3. Connectivity Requirements

Standards-Based Digital Driver		A D4i™-certified digital driver
Minimum Requirement(s) Luminaires must utilize an LED driver with standardized power, data, and sensor capabilities in compliance with D4i, as established by the DALI Alliance.		Possible Points n/a
Method of Evaluation The Expert Reviewer Panel will verify that the LED driver is compliant with D4i by checking that the driver is D4i certified using the certified products list at https://www.dali-alliance.org/products .		
Materials to Submit by Competitor (M&I Phase) <ul style="list-style-type: none"> <input type="checkbox"/> Driver literature including datasheets and installation manuals <input type="checkbox"/> Link or documentation showing D4i driver certification 		
Supplemental Testing Guidance D4i LED drivers have a mandatory set of features related to power-supply requirements and smart-data capabilities that can support digital lighting applications and interoperability. The ANSI C137.4 standard published by NEMA is equivalent to the D4i standard and includes the same specifications related to power-supply requirements and smart data capabilities. D4i certification will also demonstrate compliance with ANSI C137.4.		
A list of existing D4i certified drivers can be found at https://www.dali-alliance.org/products by selecting "Control Gear," then selecting "D4i certified."		
Referenced Documents <ul style="list-style-type: none"> • D4i • ANSI C137.4-2021: Lighting Systems – Digital Interface with Auxiliary Power • IEC 62386-101 Ed. 2.1 b:2018: Digital Addressable Lighting Interface – Part 101: General Requirements – System Components • IEC 62386-102 Ed. 2.1 b:2018: Digital Addressable Lighting Interface – Part 102: General Requirements – Control Gear • IEC 62386-207 Ed. 2.0 b:2018: Digital Addressable Lighting Interface – Part 207: Particular Requirements for Control Gear – LED Modules • DALI Part 250 – Integrated Bus Power Supply • DALI Part 251 – Memory Bank Extension • DALI Part 252 – Energy Reporting • DALI Part 253 – Diagnostics and Maintenance 		

Standards-Based Sensor Port and Connector		A Zhaga Book 20 or NEMA EM1 compliant sensor port with pre-wired connections to the D4i driver
Minimum Requirement(s) Luminaires must incorporate a standardized sensor receptacle aperture with physical shape and minimum keep-out area dimensions in compliance with Zhaga Book 20 or NEMA LS 20000-2021 shapes RR1, RR2, CC1, CC3, ORC5, or EM1. The sensor receptacle must be prewired with a Zhaga Book 20 compliant 2-wire connection to the DALI-bus terminals of the D4i driver. See the following supplemental testing guidance for important additional information about this requirement.		Possible Points n/a
Method of Evaluation The Expert Reviewer Panel will inspect the luminaire to verify that the receptacle and keepout space dimensions are compliant with the following supplemental testing guidance (Zhaga Book 20, or NEMA LS 20000-2021 shapes RR1, RR2, CC1, CC3, ORC5, or EM1) and verify that the sensor receptacle is prewired to the driver with a Zhaga Book 20-compliant connection. Various Zhaga Book 20-compliant sensors may be physically installed in the receptacle to check for physical fit.		
Materials to Submit by Competitor (M&I Phase) <ul style="list-style-type: none"> <input type="checkbox"/> n/a 		
Supplemental Testing Guidance Luminaires meeting these requirements must be capable of allowing any compliant sensing/communication module with a standardized connection to be installed in the luminaire at any point in time following completed luminaire installation with assurance of interoperability across manufacturers. Zhaga Book 20 specifies five standardized sensor receptacle shapes and associated keep-out spaces. These five shapes and keep-out spaces are equivalent to the shapes specified in NEMA LS 20000-2021 as RR1, RR2, CC1, CC3, and ORC5. RR1 and RR2 are rectangular. CC1 and CC3 are circular and use a ½" trade size knockout. ORC5 uses a circular ½" trade size knockout with an offset rectangle shape sensor form factor within the luminaire. The NEMA LS 20000-2021 EM1 also uses a circular ½" trade size knockout.		
<ul style="list-style-type: none"> • Zhaga Book 20 shape R60x22 is equivalent to NEMA LS 20000-2021 shape RR1 • Zhaga Book 20 shape R44x17 is equivalent to NEMA LS 20000-2021 shape RR2 • Zhaga Book 20 shape C22-T1B is equivalent to NEMA LS 20000-2021 shape CC1 		

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<ul style="list-style-type: none"> Zhaga Book 20 shape C22-T1A is equivalent to NEMA LS 20000-2021 shape CC3 Zhaga Book 20 shape C22-T2 is equivalent to NEMA LS 20000-2021 shape ORC5 NEMA LS 20000-2021 shape EM1 is unique to the NEMA documentation. <p>Keep-out space is the area inside and outside the luminaire where the sensor and sensor components will be mounted, which must be kept open and free from other components or elements.</p> <p>Sensing/communication module refers to any component plugged into a sensor receptacle on the luminaire, regardless of its actual functionality. The sensing/communication module could be an “internet of things” (IoT) device, or another dedicated sensor or module incorporated into a luminaire to sense motion and/or ambient lighting levels. The receptacle must be oriented such that an installed sensing/communication module would be facing the occupied space.</p>	
For luminaires that have the sensing/communication module mounted directly into the luminaire body	<p>Sensor receptacle, keep-out spaces, and attachment plug must comply with Zhaga Book 20 or NEMA shapes RR1, RR2, CC1, CC3, or ORC5 for interior dimensions.</p> <p>External keep-out dimensions are not required to meet Zhaga Book 20 or NEMA shapes RR1, RR2, CC1, CC3, or ORC5. The L-Prize does not include an external keep-out space requirement, but the external keep-out space must allow for any compliant sensing/communication module with a matching sensor receptacle shape.</p> <p>An attachment plug that connects the driver to the external sensing/communication module must be provided and the plug must comply with the attachment plug specified in the Zhaga Interface Specification Book 20.</p>
For luminaires where a sensing/communication module may be mounted externally to the luminaire body. External-mount sensing/communication modules are defined as modules where all the sensing/communication module electronics and associated housing are mounted externally to the luminaire housing. Only the mounting components and electrical connection are housed within the luminaire itself.	<p>Sensor receptacle, keep-out spaces, and attachment plug must comply with NEMA shape EM1 for interior dimensions.</p> <p>The L-Prize does not include an external keep-out space requirement, but the external keep-out space must allow for any compliant sensing/communication module with matching sensor receptacle shape.</p> <p>An attachment plug that connects the driver to the external sensing/communication module must be provided and the plug must comply with the attachment plug specified in the Zhaga Interface Specification Book 20.</p>
<p>Referenced Documents</p> <ul style="list-style-type: none"> D4i Zhaga Book 20 NEMA LS 20000-2021: Physical Interface of Luminaire-Integrated Control Devices 	

4. Product Life Cycle Requirements

Circular Design	<p>Circular design supports a closed-loop economic system that minimizes raw resource inputs as well as minimizing waste, pollution, and carbon emissions. Circular design aims to eliminate waste and maximize the continual reuse, repair, and remanufacturing of components.</p>	
Minimum Requirement(s) TM66 Circular Economy Assured quality mark for the design and manufacture of lighting products of 2 or higher.	Possible Points Five points (+5) will be awarded for luminaires that achieve a verified TM66 CEAM-Make score of ≥ 2.5 .	An additional five points (+5) will be awarded for luminaires that achieve a verified TM66 CEAM-Make score of ≥ 3 (10 points total).
<p>Method of Evaluation</p> <p>The goal of this requirement is to (1) reduce or maintain energy use over the lifetime of the luminaire, (2) extend the useful lifetime of the luminaire, (3) reduce the use and extraction of harmful materials, and (4) decrease both operational and embodied carbon impacts by using a modular design approach and by reducing materials wherever possible.</p> <p>Designing with the circular economy in mind will support these high-level goals and position luminaires and lighting systems to achieve better end-of-life outcomes. Luminaires that are designed to work within the circular economy may also be better positioned to participate in new financial models such as Efficiency-as-a-Service (EaaS), Lighting-as-a-Service (Laas), take-back models (remanufacturing), or other models that allow for servicing and upgrades throughout the lifetime of the luminaire or lighting system and at the end of life.</p> <p>The competitor will document and report the circularity of their design using the TM66 CEAM-Make digital tool and verify the score using the TM66 Assured Product Verification Scheme (from the Lighting Industry Association). The verified TM66 certificate from the Lighting Industry Association (LIA) must be submitted for review. The Expert Reviewer Panel will review the submitted certificate and will check the validity in the LIA Laboratory certification database.</p>		

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Materials to Submit by Competitor (M&I Phase) <ul style="list-style-type: none"> <input type="checkbox"/> Verified TM66 Assured Product Verification certificate from the Lighting Industry Association (LIA) <input type="checkbox"/> Completed TM66 CEAM tool
Supplemental Testing Guidance n/a
Helpful Resources and References <ul style="list-style-type: none"> • Circular Economy Assessment Method: CEAM-Make (TM66 Digital Tool) • https://www.lialabcert.org.uk/certificates-search • https://www.thelia.org.uk/page/TM66_Circularity • TM66 Training Modules • Strategies for achieving circular economy goals in the lighting industry through design for disassembly-based methodologies • Rayate V. 2012. A tool for selection of design for manufacturing and assembly rules during product design stage while considering end of life conditions. Thesis, Clemson University. • Crowther, Philip. 2005. "RAIA/BDP Environment Design Guide: Design for Disassembly – Themes and Principles." Brisbane: RAIA/BDP. • MacArthur F. 2013. "The Art of Design for Disassembly," the Ellen MacArthur Foundation.

Life Cycle Assessment	A life cycle assessment (LCA) is the systematic analysis of the potential environmental impacts (such as GHG, embodied carbon, water impacts, or human health impacts) of products or services during their life cycle.
Minimum Requirement(s) A verified life cycle assessment (LCA) and an accompanying environmental product declaration (EPD) including, at a minimum, life cycle stages A1-A5 (production and construction), B1-B7 (use), and C1-C4 (end-of-life) in accordance with ISO 21930:2017	Possible Points n/a
Method of Evaluation The Expert Reviewer Panel will review the submitted LCA to check that it is verified and addresses all required stages, and that the associated EPD is based on the verified LCA. A "verified" LCA means that the LCA has been peer-reviewed by an expert 3 rd party that provides LCA verification services to determine that the LCA is in accordance with ISO 14040 and that the inputs and analysis are correct.	
Materials to Submit by Competitor (M&I Phase) <ul style="list-style-type: none"> <input type="checkbox"/> Verified life cycle assessment (LCA) including documentation of the verification, and <input type="checkbox"/> an accompanying environmental product declaration (EPD) 	
Supplemental Guidance PNNL has developed a free, open-source, standardized luminaire-specific life cycle inventory (LCI) template that can be used by manufacturers and LCA practitioners to streamline and simplify data collection. At the time of this publication, the beta template/tool is available; however the next version of this template will be aligned with the upcoming North American Luminaire product category rules that are currently in development. Teams are encouraged to start with the fully functional beta template/tool and switch over to the updated version when it is available.	
Helpful Resources <ul style="list-style-type: none"> • A list of LCA practitioners can be found at https://www.environdec.com/resources/lca-consultants (enter "United States" to show all U.S. providers) • PNNL Life Cycle Inventory Template for Luminaires • Forthcoming update to ANSI/IES LP-10-20: Sustainable Lighting—Introduction to Environmental Impacts of Lighting. 	

Replaceable Components	The ability to easily replace individual components of a luminaire without having to move or replace the entire luminaire. Examples of replaceable components include LED light engines, LED arrays or modules, and drivers or power supplies.
Minimum Requirement(s) The LED driver and LED array/module or LED light engine shall be replaceable using conventional, readily available tools while the luminaire remains in place. If separate from the driver or LED light engine, the LED control circuitry (as defined in ANSI/IES LS-1-22) shall also be replaceable.	Possible Points n/a
Method of Evaluation The Expert Reviewer Panel will follow the instructions provided by the competitor through their label or marking (see "Labeling and Markings" requirement below) to verify that the LED driver and LED array/module or LED light engine are replaceable using conventional tools while the luminaire remains in place.	
Materials to Submit by Competitor (M&I Phase) <ul style="list-style-type: none"> <input type="checkbox"/> See "Labeling and Markings" requirement 	

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Supplemental Guidance If a luminaire utilizes an LED light engine (combined LED driver and LED module/array), then only the light engine as a whole is required to be replaceable. Conventional, readily available tools means “Common General Purpose Tools” as described in Annex A - Table 2 of <i>BS EN 45554:2020 General methods for the assessment of the ability to repair, reuse and upgrade energy-related products</i> . These acceptable tools include: <ul style="list-style-type: none"> • Hammer - Steelhead (ISO 15601) • Combination pliers (ISO 5746) • Half-round nose pliers (ISO 5745) • Multi grip pliers (ISO 8976) • Diagonal cutters (ISO 5749) • Combination wrench (ISO 10664) • Combination pliers + wire stripping + terminal crimping • Screwdriver for cross heads (Philips & Pozi-Drive Heads) (ISO 8764) • Screwdriver hexalobular (torx-head) (ISO 10664) • Hexagon socket key (Allen-Key) (ISO 2936) • Screwdriver slotted heads (ISO 2380) • Utility knife (cutter) snap-on-blades • Multimeter Other tools not on this list may be allowed if they are commonly available throughout the United States in retail, hardware, or home improvement stores, as determined by the Expert Reviewer Panel.	
Helpful Resources <ul style="list-style-type: none"> • ANSI/IES LS-1-22, Lighting Science: Nomenclature and Definitions for Illuminating Engineering • BS EN 45554:2020 General methods for the assessment of the ability to repair, reuse and upgrade energy-related products 	

Labeling and Markings		Product labels or markings that provide information about servicing, disassembly, and end-of-life.
Minimum Requirement(s) 1. The luminaire shall include a label or marking on or embedded in the luminaire in an easily accessible and visible location that leads to the manufacturer’s website for detailed instructions and guides to support servicing, disassembly, and end-of-life. 2. Luminaire subcomponents that are modular, removeable, or serviceable shall include labeling or markings with information to indicate how they should be removed and who can perform the modifications. The labeling or markings shall address all topics listed in the supplemental guidance section that follows this table.		Possible Points n/a
Method of Evaluation The Expert Reviewer Panel will review luminaires and subcomponent labels and markings to verify that they meet minimum requirements.		
Materials to Submit by Competitor (M&I Phase) <input type="checkbox"/> n/a		
Supplemental Guidance The luminaire labels or markings shall direct users to a website hosted by the manufacturer that includes at minimum the following information: <ul style="list-style-type: none"> • Who can service or modify the luminaire (e.g., qualifications) • What tools are required • Servicing instructions • Safety implications (e.g., like voiding UL listing/avoiding shock) • What parts are modular/replaceable/serviceable • Disassembly diagram including: <ul style="list-style-type: none"> ○ Disassembly instructions ○ Identification of parts by materials and recycling information including recycling codes (if available). 		
Helpful Resources <ul style="list-style-type: none"> • CIBSE, 2021. TM66 Creating a circular economy in the lighting industry (2021) • Hickcox and Smith, 2022. Strategies for achieving circular economy goals in the lighting industry through design for disassembly-based methodologies 		

Materials and Sustainability	Innovations that reduce embodied carbon , support improved
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Innovation		material transparency ¹⁰ , and/or improve material health ¹¹
Minimum Requirement(s) No minimum requirement		Possible Points Up to ten points (+10) will be awarded for successful submissions and documentation addressing the high-level goals and the submission requirements outlined below.
Method of Evaluation DOE is looking for essay-style summaries or descriptions and documentation describing the reduced embodied carbon, material transparency (such as reporting or documentation), and/or improved material health. Summaries should describe the problems or issues that were addressed, how these problems or issues were discovered or researched, the solution(s), and any iterations that are of interest in the process of arriving at the final solution. The submitted documentation will be judged by the Expert Reviewer Panel based on the quality of the content, approach, and arguments, and the scoring statement and scoring approach detailed as follows.		
The Expert Reviewer Panel will score the following statement: The competitor submitted a narrative or documentation that clearly described an innovation which reduced embodied carbon, improved material transparency, or improved material health of the luminaire or manufacturing process.		Scoring Approach: Scored 0 to 10 0 = strongly disagree or no submission 2 = disagree 4 = slightly disagree 6 = slightly agree 8 = agree 10 = strongly agree
Materials to Submit by Competitor (M&I Phase) <input type="checkbox"/> Up to two-page PDF narrative describing material transparency and material health innovations (optional)		
Supplemental Guidance Some examples of innovations that support improved material transparency or material health (not inclusive) may include: <ul style="list-style-type: none"> Innovations that address the embodied carbon impacts of the luminaire (narrative must include data or calculations to support claimed embodied carbon reductions or approaches) Innovations that use recycled, biodegradable, biodegradable, or low-toxicity materials Innovations that identify and/or reduce the use of harmful materials, for example using the International Living Future Institute Declare or Red List Innovations that restore, renew, or revitalize their own sources of energy and materials Innovative approaches to quantifying material sustainability impacts and/or communicating these to end-users Innovations that reduce recovery processes (shredding) and increase recycling processes Innovations that support take-back programs or reuse or remanufacturing of parts or components Innovations that include labeling of parts or components or other information systems to communicate end-of-life strategies 		
Helpful Resources <ul style="list-style-type: none"> https://living-future.org/biophilic-design/ https://living-future.org/red-list/ https://living-future.org/declare/ https://living-future.org/lpc/ European Union. 2008. DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. Brussels: EU. U.S. EPA, United States Environmental Protection Agency. n.d. Waste Management Hierarchy and Homeland Security Incidents. U.S. EPA. Accessed June 17, 2022. https://www.epa.gov/homeland-security-waste/waste-management-hierarchy-and-homeland-security-incidents. Crowther, Philip. 2005. "RAIA/BDP Environment Design Guide: Design for Disassembly – Themes and Principles." Brisbane: RAIA/BDP. MacArthur F. 2013. "The Art of Design for Disassembly," the Ellen MacArthur Foundation. 		

Lumen Maintenance		The elapsed operating time at which the specified percentage of the initial light output is reached, expressed in hours
Minimum Requirement(s) The luminaire must maintain 90% of the initial light output for at least 36,000 hours ($L_{90} \geq 36,000$ hrs), and 70% of the initial light output for at least 50,000 hours ($L_{70} \geq 50,000$ hrs).		Possible Points n/a
Method of Evaluation The Expert Reviewer Panel will review the submitted ANSI/IES LM-80 test report(s), ISTMT test report, and ANSI/IES TM-21 calculation to verify compliance with the requirements.		
Materials to Submit by Competitor (M&I Phase) <input type="checkbox"/> ANSI/IES LM-80 test report		

¹⁰ Material transparency refers to the disclosure of the ingredients and processes used to create materials or products, and their potential human health effects, environmental impacts, or social equity in manufacturing and recycling or disposal.

¹¹ Material health describes the sustainability quality or "health" of materials themselves, and how these materials may affect humans and ecosystems. Material health includes knowledge about chemicals used in products across their supply chains and chemicals of concern.

¹² Some examples of biodegradable components may include biodegradable circuit boards or biopolymers used in additive (3D) printing, but there are many other examples not listed. See definitions from the [United States Department of Agriculture](#) and the [United States Environmental Protection Agency Science Inventory](#).

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<input type="checkbox"/> ISTMT test report <input type="checkbox"/> ANSI/IES TM-21-21 calculation
Supplemental Testing Guidance See Appendix D for additional information regarding the required ISTMT test.
Referenced Documents <ul style="list-style-type: none"> • ANSI/IES LM-80-20: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules • ANSI/IES TM-21-21: Projecting Long-Term Lumen, Photon, and Radiant Flux Maintenance of LED Light Sources • ANSI/IES TM-21-21 Calculator

Chromaticity Maintenance		A shift in the appearance of color of a light source that occurs over time	
Minimum Requirement(s) The change of chromaticity over the initial 6,000 hours of operation must be ≤ 0.002 , calculated as the distance between coordinate pairs on the CIE 1976 (u',v') diagram.		Possible Points n/a	
Method of Evaluation The Expert Reviewer Panel will review the submitted LM-80 report(s) to verify the chromaticity maintenance of LEDs used in the product.			
Materials to Submit by Competitor (M&I Phase) <div><input type="checkbox"/> ANSI/IES LM-80-20 test report for each LED type used</div>			
Supplemental Testing Guidance n/a			
Referenced Documents <ul style="list-style-type: none">ANSI/IES LM-80-20: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules			

Driver Lifetime	The amount of time an LED driver is expected to perform its intended functions under a specific set of environmental, electrical, and mechanical conditions, expressed using an appropriate statistical metric	
Minimum Requirement(s) The measured temperature of the driver at the temperature measurement point (TMP), specified by the driver manufacturer and tested in situ, must be less than or equal to the maximum case temperature for which the driver is designed to last ≥50,000 hrs.	Possible Points n/a	
Method of Evaluation The Expert Reviewer Panel will review the LED driver ISTMT test report and driver data sheet to verify compliance with the requirements.		
Materials to Submit by Competitor (M&I Phase) <ul style="list-style-type: none"><input type="checkbox"/> Driver ISTMT test report<input type="checkbox"/> Photographic documentation of the actual thermocouple applied to the temperature measurement point with an arrow indicating the thermocouple attachment point<input type="checkbox"/> Datasheet or documentation from the driver manufacturer that indicates the maximum case temperature for which the driver is designed to last ≥50,000 hours, as well as the TMP location it designates for thermal testing		
Supplemental Testing Guidance Custom and integrated drivers must provide documentation equivalent to that required for drivers from third-party vendors.		
Referenced Documents <ul style="list-style-type: none">n/a		

5. Technical Innovation

Technical Innovation	Technical innovation that is beyond the prescriptive minimum requirements and associated points	
Minimum Requirement(s) No minimum requirement	Possible Points Up to fifty points (+50) will be awarded for technical innovation as scored by the Expert Reviewer Panel.	
Criterion: Application Efficiency	The Expert Reviewer Panel will score the following statement: The luminaire includes impactful innovations that improve the in-application	Scoring Approach: <u>Each Criterion</u>

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	efficiency beyond luminaire efficacy such as improved optics/distribution that better distribute light while increasing comfort and/or reducing glare.	Scored 0 to 10 0 = strongly disagree or no submission 2 = disagree 4 = slightly disagree 6 = slightly agree 8 = agree 10 = strongly agree
Criterion: Form Factor and Aesthetics	The Expert Reviewer Panel will score the following statement: The luminaire includes impactful innovations in form factor and/or aesthetics that improve the acceptability and adoptability of the solution in the application it is intended for (e.g., more design oriented, or aimed for broad adoption).	
Criterion: Ease of Installation	The Expert Reviewer Panel will score the following statement: The luminaire includes impactful innovations that improve the ease and/or standardization of installation, both of which can lead to wider adoption of energy efficient technologies.	
Criterion: Affordability and Value Proposition	The Expert Reviewer Panel will score the following statement: The luminaire includes impactful innovations that reduce up-front cost, improve the ability of users to afford it, and/or improve the value proposition of the technology or luminaire.	
Criterion: Health and Wellbeing	The Expert Reviewer Panel will score the following statement: The luminaire includes impactful and science-backed innovations that can improve the health and/or wellbeing of students, workers, and/or other building occupants.	
Method of Evaluation The Expert Reviewer Panel will review materials submitted by the competitor and conduct a physical evaluation of the installed luminaire. Each Expert Reviewer Panel member will then score the submission based on the four statements shown above. DOE is seeking innovation that addresses current market or technology opportunities and limitations and will lead to increased adoption of high efficiency, high quality, interoperable luminaires. Some additional explanation and examples that would address each of the scoring statements above (not inclusive) are provided below. <ul style="list-style-type: none"> Innovations that improve application efficiency beyond luminaire efficacy such as improved optics or distribution that can reduce required light output or number of luminaires needed to light a space. Innovations that deliver exceptional in-application glare performance while maintaining high efficacy and excellent distribution of light beyond the L-Prize minimum prescriptive requirement of $UGR \leq 22$ or an alternative submitted approach. Innovations that improve ease of installation and/or standardization of installation to improve cost-effectiveness and/or help ensure successful installations by existing contractors and facility personnel. Innovations that reduce the cost or improve the affordability of the luminaire for a wide range of users, including small buildings/businesses, disadvantaged communities, and those with limited budgets. Innovations that are supported by science and data that may improve the health or wellbeing of people that work in or occupy rooms in which the luminaires are installed. Innovations should be beyond what is traditionally available with today's commercially available luminaires. 		
Materials to Submit by Competitor (M&I Phase) <ul style="list-style-type: none"> <input type="checkbox"/> Up to two-page PDF narrative describing any innovations beyond luminaire efficacy that improve the application efficiency of the luminaire. The narratives should quantify the application efficiency benefit and include technical justifications or engineering analysis to support the claimed innovation. (optional) <input type="checkbox"/> Up to two-page PDF narrative describing any innovations in form factor and aesthetics that will improve the acceptability and adoptability of the solution. Narratives should specifically describe the problem or opportunity that the aesthetic or form factor innovation addresses and include any supporting data or analysis to quantify the potential benefit in terms of adoptability, as feasible. (optional) <input type="checkbox"/> Up to two-page PDF narrative describing any impactful innovations that improve the ease of installation and/or standardization of installation, both of which can lead to wider adoption of energy technologies. (optional) <input type="checkbox"/> Up to two-page PDF narrative describing any innovations that improve the value proposition and cost-effectiveness or reduce the cost of the luminaire relative to currently available luminaires. Narratives must include estimated distributor net pricing information for a quantity of 20 luminaires and quantify how the luminaire design improves affordability and value proposition compared to currently available luminaires. (optional) <input type="checkbox"/> Up to two-page PDF narrative describing any innovations that can improve the health and/or wellbeing of students, workers, or other building occupants that work or occupy rooms in which the luminaire is installed. The narrative must include the scientific basis, data, and associated citations for any health and wellbeing benefit claims. (optional) 		
Supplemental Testing Guidance n/a		
Referenced Documents <ul style="list-style-type: none"> DOE 2022 Solid-State Lighting R&D Opportunities, section 2.7: Lighting Application Efficiency Schwartz, Emily K., and Moncef Krarti. 2022. "Review of Adoption Status of Sustainable Energy Technologies in the US Residential Building Sector" <i>Energies</i> 15, no. 6: 2027. https://doi.org/10.3390/en15062027 		

6. U.S. Content, Production, and Installation

U.S. Content	The total U.S. content of the luminaire including assembly, materials, components, and subsystem components
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APPENDIX A: Luminaire Track Technical Requirements

Minimum Requirement(s) The final assembly of the finished luminaire (including integral subsystem components such as the housing, driver, LED modules, integral sensors, optics, etc.) must take place in the United States.		Possible Points Up to fifteen points (+15) will be awarded for additional U.S. content beyond U.S. assembly as scored by the Expert Reviewer Panel.
Criterion: U.S. Content	The Expert Reviewer Panel will score the following statement: The competitor's luminaire includes significant U.S. content beyond U.S.-based luminaire assembly such as U.S. sourcing, manufacturing, and/or assembly of individual materials, components, or subcomponents.	Scoring Approach: Scored 0 to 15 0 = strongly disagree or no submission 5 = disagree 10 = agree 15 = strongly agree
Method of Evaluation The Expert Reviewer Panel will review the competitor's U.S. Content Narrative and determine if the minimum requirement has been met and any additional points that are earned. DOE and/or representatives of the Expert Reviewer Panel may visit the luminaire assembly site.		
Materials to Submit by Competitor <input type="checkbox"/> U.S. Content Narrative: Up to two-page narrative in PDF format that includes at minimum: <ul style="list-style-type: none"> ○ A bill of materials for all components within the luminaire and their associated country of origin. ○ The location, facilities description, and capabilities where the luminaire is assembled. DOE may visit the luminaire assembly site. ○ A step-by-step description of the assembly process. ○ Any additional U.S. content to be considered by the Expert Reviewer Panel, such as U.S. sourcing, manufacturing, and/or assembly of materials, components, or subcomponents beyond the final luminaire assembly. 		
Supplemental Testing Guidance n/a		
Referenced Documents <ul style="list-style-type: none"> • n/a 		

Production and Deployment Plan		The capabilities and plan to manufacture and deploy the luminaire in commercial buildings
Minimum Requirement(s) The competitor must provide a documented plan that describes the competitor's capabilities and strategy to manufacture the luminaire and a go-to-market strategy to deploy the luminaire to large numbers of commercial buildings. The plan must address all points listed in the Supplemental Guidance section in this table.		Possible Points Up to fifteen points (+15) will be awarded for the quality, credibility, and responsiveness of the production and deployment plan that documents production capabilities and effective go-to-market strategies.
Criterion: Production and Deployment Plan	The Expert Reviewer Panel will score the following statement: The competitor submitted a well-documented, comprehensive, credible plan that demonstrates significant capabilities to manufacture the luminaire in large quantities and an effective go-to-market strategy that will deploy the luminaire to large numbers of commercial buildings.	Scoring Approach: Scored 0 to 15 0 = strongly disagree or no submission 5 = disagree 10 = agree 15 = strongly agree
Method of Evaluation The Expert Reviewer Panel will review the competitor's Production and Deployment Plan to check that the minimum requirement is met. The submitted documentation will be judged by the Expert Reviewer Panel based on the quality, credibility, and responsiveness of the plan to demonstrate significant capabilities to manufacture and deploy the luminaire to large numbers of commercial buildings. DOE may visit the manufacturing/assembly site to verify what is described in the plan.		
Materials to Submit by Competitor <input type="checkbox"/> Production and Deployment Plan.		
Supplemental Guidance The Production and Deployment Plan should, at minimum, include the following information: <ul style="list-style-type: none"> • How and where the luminaire is manufactured and assembled, including subsystem components • How many luminaires are expected to be produced and production capacity limits, and description of the variables that impact production amounts and limits • A quality control plan to ensure high-quality manufacturing and products • A go-to-market strategy that will result in significant quantities of the luminaire being deployed in commercial buildings. The go-to-market strategy should include, at minimum, information to answer the following questions: <ul style="list-style-type: none"> ○ What is the target market(s) for the luminaire? Provide characteristics of the target market(s) including size and sales or adoption potential. ○ What is the foreseen volume over 1, 3, and 5 years? ○ What are the key value propositions? What problems is the luminaire solving or what new value is it providing? ○ What are the key adoption hurdles, and how will they be addressed? For example, if the luminaire is expected to have a significant price premium that may inhibit sales or adoption, how will this challenge be addressed? ○ What channels and methods will be used to deploy the luminaire to the target market? ○ How will the luminaire be marketed? What are the key messages and methods? 		
Referenced Documents <ul style="list-style-type: none"> • n/a 		

APPENDIX A: Luminaire Track Technical Requirements

U.S. Installation	Real installation(s) of at least 20 luminaires at U.S.-based host site location(s)
<p>Minimum Requirement(s)</p> <p>The competitor must document at least one, and no more than three, U.S. installation(s) that can be physically visited by DOE. The installation(s) must comprise at least 20 of the submitted luminaires in total (with the exact specifications as the tested luminaire) across all installation site(s). At least one of the installations must include at least one room/space where at least four of the luminaires are installed. Installation(s) must be in one of the targeted applications of the L-Prize, as described in section I.3: TARGETED APPLICATIONS, SYSTEMS, AND LUMINAIRE TYPES. The installation must utilize the commercially available and manufactured luminaires submitted for entry, and should not utilize any prototype luminaires. The host site must not be owned by the competitor or by a business partner of the competitor, such as a sales representative. DOE and the Expert Reviewer Panel may visit the site(s) to observe, document, and confirm the installations.</p>	<p>Possible Points</p> <p>n/a</p>
<p>Method of Evaluation</p> <p>The Expert Reviewer Panel will review the competitor's submitted documentation and may visit installation site(s). Successfully meeting the minimum requirement means that the submitted documentation includes all requested information and that all luminaires at the installation site(s) are successfully installed and functioning with at minimum on, off, and dimming control.</p>	
<p>Materials to Submit by Competitor</p> <ul style="list-style-type: none"> □ A site installation document must be provided in PDF format that includes the following: <ul style="list-style-type: none"> ○ Contact information for the owner or manager (or other appropriate representative) at the installation site ○ A reflected ceiling plan (RCP) showing luminaire locations and control(s) ○ A luminaire schedule showing quantities and luminaire specifications ○ Energy code compliance documentation in the form of a COMcheck report that quantifies the lighting power density of the installed applications ○ Construction permit compliance documentation. 	
<p>Supplemental Guidance</p> <p>For linear luminaires typically installed in continuous runs, each 4-foot section is considered to be a single luminaire for the purposes of meeting this requirement.</p> <p>Each luminaire at the installation site must include the sensor port, in compliance with the Standards-Based Sensor Port and Connector requirement, but are not required to have a sensor installed. This can demonstrate the field upgradeable capability of the luminaire to sensor and controls. For linear form factor luminaires installed in continuous runs, only one luminaire on one end of the run is required to have the sensor port.</p> <p>Competitors may use either the desktop version of COMcheck or COMcheck-Web. Competitors should select the applicable energy code for their installation site location.</p> <p>While visiting the installation site(s), the Expert Reviewer Panel may consider their observations at the site(s) in addition to their laboratory-based evaluations in scoring other topic areas of L-Prize, such as Application Efficiency, Form Factor and Aesthetics, and Ease of Installation.</p> <p>DOE will take and publicize photos of the installation site(s), but will not identify the site name, owner, and location(s) without appropriate permissions. In selecting their installation site, competitors must ensure site owners will allow at minimum anonymized photos of the installations to be publicized.</p> <p>DOE may seek ongoing feedback and evaluation from the site and may develop a case study should the host site agree to participate. This ongoing feedback, evaluation, and case study development are not within the scope of the M&I Phase and would be negotiated with the competitor and host site owner following the completion of the M&I Phase.</p>	
<p>Referenced Documents</p> <ul style="list-style-type: none"> • COMcheck 	

Commercial

The commercial availability of the luminaire including complete product literature and marketing materials

APPENDIX A: Luminaire Track Technical Requirements

Availability	
Minimum Requirement(s) The luminaire must be fully commercially available for purchase with complete, final documentation and literature readily available on the manufacturer’s website. The luminaire must also be certified with all appropriate electrical and fire safety certifications.	Possible Points n/a
Method of Evaluation The Expert Reviewer Panel will review the competitor’s website, marketing materials, and product literature.	
Materials to Submit by Competitor <ul style="list-style-type: none"> <input type="checkbox"/> Location of product website listing and spec sheets, marketing materials, installation guides, and other relevant product documentation to indicate full commercial availability <input type="checkbox"/> Documentation demonstrating appropriate safety certifications of the luminaire from a recognized safety certification body such as UL, CSA, or ETL. 	
Supplemental Guidance Draft materials may be submitted initially and evaluated by the Expert Reviewer Panel. However, the final determination and announcement of the award will not be made until final materials are made available on a publicly available website.	
Referenced Documents <ul style="list-style-type: none"> • n/a 	

APPENDIX B: Connected Systems Track Technical Requirements

The L-Prize Connected Systems Track technical requirements are organized into four categories: connectivity; product life cycle; technical innovation; and U.S. content, production, and installation. Each technical requirement in this appendix includes:

- Definition of the requirement
- Description of the minimum requirement
- Description of the points that may be earned
- Description of the method of evaluation
- Technical materials that competitors must submit for each phase to support each requirement
- Supplemental guidance as required
- Referenced documents or standards.

A summary of these requirements and available points can be found in [TABLE 4](#).

1. Connectivity Requirements

Standards-Based Luminaire or System Controller	An interface that enables the connected system to communicate with a luminaire that has a D4i-certified digital driver or sensing/communication module	
Minimum Requirement(s) The connected system must be able to communicate with and control luminaires that have D4i-certified drivers and/or sensing/communication modules and able to leverage the standardized data stored in the driver memory banks. Communication from the connected system to the luminaires shall occur through either a) a wireless connection to a competitor-provided D4i sensor/controller installed in a luminaire Zhaga Book 20 sensor port, or b) a wired connection. If a wired connection is used, it may be directly connected to the D4i driver, or connected through a sensor/controller installed in the luminaire Zhaga Book 20 sensor port, or through another means of attachment to the luminaire.	Possible Points n/a	
	Method of Evaluation The Expert Reviewer Panel will verify that the Connected System can communicate and control luminaires with D4i certified drivers. DOE will post a detailed physical test and evaluation plan (which the Expert Reviewer Panel will follow to evaluate the systems) on https://www.herox.com/LPrize/resources .	
	Materials to Submit by Competitor (M&I Phase) n/a	
	Supplemental Testing Guidance n/a	
	Referenced Documents <ul style="list-style-type: none"> • D4i • Zhaga Book 20 	

Technical Interoperability	The capability to physically connect two or more devices or systems	
Minimum Requirement(s) The lighting system must include network interfaces incorporated into system devices to enable exchange of data with other system devices. The interfaces must comply with at least one existing industry standard specification for basic physical network connectivity, such as: IEEE 802.3 (Ethernet), IEEE 802.11 (Wi-Fi), IEEE 802.15.4 (ZigBee, 6LoWPAN), Bluetooth Mesh, etc.	Possible Points n/a	

Appendix B: Connected Systems Track Technical Requirements

Method of Evaluation
The Expert Reviewer Panel will review the manufacturer's submitted system and component literature to verify compliance with the requirements.
Materials to Submit by Competitor (M&I Phase)
<input type="checkbox"/> Manufacturer documentation that identifies the industry standard or specification used for physical network connectivity.
Supplemental Testing Guidance
n/a
Referenced Documents
n/a

Application Interoperability	The capability to exchange actionable information between two or more devices or systems
<p>Minimum Requirement(s)</p> <p>The lighting system must provide an application programming interface (API) for application-level interoperability.</p> <p>At a minimum, the API shall provide access to: 1) individual luminaire occupancy data, 2) individual luminaire energy use data, 3) lighting zone characteristics: luminaires within the zone, control strategies, room name, space type, and any other related metadata, 4) individual zone occupancy data, 5) individual zone energy use data, and 6) automated fault detection and diagnostics (FDD) data. FDD and energy reporting data must align and comply with the separate FDD and Energy Reporting requirements contained in this L-Prize rules document.</p> <p>A single Postman collection file and a single Postman environment file with all the variables and endpoints that can be expected to be used during testing shall be submitted. All API calls shall rely only on RESTful methods and not require invoking any other protocol (e.g., WebSockets, Cap'n Proto, etc.) to retrieve the data.</p> <p>API developer documentation and an OpenAPI specification (OAS) document encoded in JSON shall be submitted. The submitted documentation shall include, at a minimum: authentication guidance; API resources guidance including all endpoints, error codes, and debugging guidance; an up-to-date changelog; and terms of use.</p>	<p>Possible Points</p> <p>Ten points (+10) will be awarded to lighting systems that have a BACnet interface that is certified by BACnet Testing Laboratories and is capable of sharing data with building management and HVAC systems. The interface shall enable the lighting system to share the following data 1) lighting zone cumulative energy use, and 2) lighting zone occupancy status. A BACnet Objects Table shall be provided for each data type. See Supplemental Testing Guidance below for more information.</p> <p>An additional five points (+5) will be awarded to lighting systems that are capable of calculating a customized HVAC zone occupancy and sharing HVAC zone occupancy status with HVAC systems via the same BACnet interface. A BACnet Objects Table shall be provided for the HVAC zone occupancy data type. See Supplemental Testing Guidance below for more information.</p>
<p>Method of Evaluation</p> <p>The Expert Reviewer Panel will review the manufacturer's API documentation to verify compliance with the requirements. The Expert Reviewer Panel will also conduct a laboratory test to query the system API to confirm that the required data are available. The Expert Reviewer Panel will check whether any devices/interfaces are listed on the BACnet Certified Products list and review manufacturer documentation to determine whether any points will be earned.</p>	
<p>Materials to Submit by Competitor (M&I Phase)</p> <ul style="list-style-type: none"> <input type="checkbox"/> OpenAPI specification (OAS) document and API development documentation that include at minimum: <ul style="list-style-type: none"> o Authentication guidance o API resources guidance including all endpoints o Error codes o Debugging guidance o Up-to-date changelog o Terms of use. <input type="checkbox"/> Single Postman collection file <input type="checkbox"/> Single Postman environment file <input type="checkbox"/> BACnet Certified Products listing information (if applicable) <input type="checkbox"/> BACnet Protocol Implementation Conformance Statement (PICS) (if applicable) <input type="checkbox"/> BACnet Objects Table for lighting zone cumulative energy data (if applicable) <input type="checkbox"/> BACnet Objects Table for lighting zone occupancy status (if applicable) <input type="checkbox"/> BACnet Objects Table for HVAC zone occupancy status (if applicable) <input type="checkbox"/> Documentation that describes how to customize the calculation of HVAC zone occupancy (if applicable). 	
<p>Supplemental Testing Guidance</p> <p><u>Open API</u></p> <p>The OpenAPI specification does not specify what or how endpoints must be exposed via an API but instead specifies how the APIs must be described. For competitor APIs that are already implemented and were designed using the OpenAPI framework (i.e., an API-first design approach, where the OpenAPI document is created upfront and code is then written to create the implementation), the implementations shall be annotated so that an OpenAPI document can be generated. See https://www.openapis.org/ for more information.</p>	

Appendix B: Connected Systems Track Technical Requirements

BACnet Interface with energy use and lighting zone occupancy data (+10 points)

The lighting system shall be capable of sharing data with other systems via a BACnet interface. The interface may be provided by any suitable means (e.g., BACnet device, gateway, API).

- The lighting system component that provides the BACnet interface shall be certified and listed on the BTL certified products website.
- The BACnet interface shall use a BACnet IP (Annex J) data link layer.
- The BACnet interface shall use one of the following BACnet Controller—General Purpose Device Profiles: Building Controller (B-BC), Advanced Application Controller (B-AAC), Application Specific Controller (B-ASC), Smart Sensor (B-SS).
- The BACnet interface shall be documented using a [BACnet Protocol Implementation Conformance Statement \(PICS\)](#).
- The lighting system shall be capable of sharing lighting zone cumulative energy use, as specified in the Energy Reporting requirement in Appendix B. The BACnet Objects that support the sharing of this data shall be documented in a table of the following form:

Object Name	Object Description	Object ID	Grouping [Y/N – Grouping Process]	Access	Object Type	Instance ID
Lighting Zone Cumulative Energy Use (required)	Cumulative energy use of all luminaires in a configured Lighting Zone		Y – SUM	Read	Analog Input	
Other (Optional)						

- The lighting system shall be capable of sharing lighting zone occupancy status. The lighting zone occupancy status shall be suitable for HVAC zone temperature setback control strategies (e.g., occupied standby control). The BACnet Objects that support the sharing of this data shall be documented in a table of the following form:

Object Name	Object Description	Object ID	Grouping [Y/N – Grouping Process]	Access	Object Type	Instance ID
Lighting Zone Occupancy Status (required)	State of occupancy in a configured Lighting Zone 1: Occupied 0: Unoccupied		Y – OR	Read	Binary Input	
Lighting Zone Temperature (Optional)	Average temperature in configured Lighting Zone		Y – Average	Read	Analog Input	
Other (Optional)						

BACnet Interface with HVAC zone occupancy data (additional +5 points)

- The lighting system shall be capable of calculating a customized HVAC zone occupancy status.
 - The HVAC zone occupancy status shall be customizable via Boolean operations performed on sets of lighting or zone occupancy status. For example, if an HVAC zone occupancy status HZ1 is to be determined from lighting occupancy zones LZ1, LZ2, LZ3, then this capability might be used to configure HZ1 occupancy according to the following expressions: HZ1 = [LZ1 OR LZ2 OR LZ3], HZ1 = [LZ1 AND LZ2 AND LZ3], HZ1 = [LZ1 OR (LZ2 AND LZ3)], HZ1 = [LZ1 AND (LZ2 OR LZ3)].
 - Documentation shall be provided that describes how to configure the Boolean operations via a user interface, configuration file, or other suitable means.
 - The lighting system shall be capable of sharing customized HVAC zone occupancy status with other systems via a BACnet/IP interface. The BACnet Objects that support the sharing of this data shall be documented in a table of the following form:

Object Name	Object Description	Object ID	Grouping [Y/N – Grouping Process]	Access	Object Type	Instance ID
HVAC Zone Occupancy Status (required)	State of occupancy in a configured HVAC Zone 1: Occupied 0: Unoccupied		Y – Customized	Read	Binary Input	
HVAC Zone Temperature (Optional)	Average temperature in configured Lighting Zone		Y – Average	Read	Analog Input	
Other (Optional)						

Referenced Documents

- <https://www.bacnetinternational.net/btl/>
- [BACnet Protocol Implementation Conformance Statement \(PICS\)](#)

Appendix B: Connected Systems Track Technical Requirements

Addressability		The capability to uniquely identify and/or address each lighting system luminaire and device digitally via software	
Minimum Requirement(s) The system must have the ability to uniquely identify and/or address each individual system device. The system must allow for configuration and reconfiguration of devices and control zones independent of electrical circuiting.		Possible Points n/a	
Method of Evaluation The Expert Reviewer Panel will review the manufacturer’s submitted system and component literature to verify compliance with the requirements.			
Materials to Submit by Competitor (M&I Phase) <div><input type="checkbox"/> System and component literature including datasheets, and installation and configuration manuals</div> <div><input type="checkbox"/> Instructions to Expert Reviewer Panel for how to demonstrate requirement.</div>			
Supplemental Testing Guidance n/a			
Referenced Documents n/a			

Cybersecurity		The capability to protect networks, devices, and data from unauthorized access or malicious use	
Minimum Requirement(s) The system must be certified by a third-party certification body for cybersecurity performance, using the same approach and allowed cybersecurity certifications as the DesignLights Consortium (DLC) Technical Requirements for Networked Lighting Controls, Version 5.0 or newer. Acceptable certifications and services include SOC 2, ISO/IEC 27001, ISO/IEC 27017, FedRAMP, CSA STAR, PSA Certified, ANSI/UL 2900-1, ANSI/ISA/IEC 62443, ioXt, UL IoT Security Rating (UL 1376), CSA Cybersecurity Verification Program (CVP) (CSA T200), and Intertek Cyber Assured.		Possible Points n/a	
Method of Evaluation The Expert Reviewer Panel will review the letter or certificate of compliance provided by the third-party cybersecurity certification organization. The Expert Reviewer Panel may also review certification registries and request additional information as required from the competitor to verify that the requirement is met.			
Materials to Submit by Competitor (M&I Phase) <div><input type="checkbox"/> Letter or certificate of compliance from third-party cybersecurity certification organization.</div>			
Supplemental Testing Guidance n/a			
Referenced Documents <ul style="list-style-type: none">DLC NLC5 Technical RequirementsDLC NLC5 Cybersecurity Overview			

Energy Reporting	The capability of the connected system to measure and report the lighting system energy use	
Minimum Requirement(s) System luminaires with D4i drivers shall be considered TE Class Energy Reporting Devices (ERDs) in accordance with ANSI C137.5-2021. The connected system must report the cumulative (not interval) energy use for each luminaire ERD including the self-consumption of the ERD, power conversion losses, and attached loads powered by the D4i driver. every addressable system device (excluding battery powered devices), including the energy consumed by downstream devices, if applicable. The cumulative (not interval) energy data must be reported for 15-minute (or shorter) intervals and must be reported via API, using a described data model (e.g., as documented in an API). The system must be able to store data for at least 24 months. The system must use automated energy measurement and must not use a methodology that requires manual input during system setup for accurate measurement (such as input wattage of each lamp/luminaire).	Possible Points n/a	

Appendix B: Connected Systems Track Technical Requirements

Method of Evaluation
The Expert Reviewer Panel will review the manufacturer's submitted system and component literature to verify compliance with the requirements. The Expert Reviewer Panel will also install the system in the laboratory and verify compliance with the requirements.
Materials to Submit by Competitor (M&I Phase)
<input type="checkbox"/> System and component literature including datasheets, and installation and configuration manuals <input type="checkbox"/> Instructions to Expert Reviewer Panel for how to demonstrate the requirement
Supplemental Testing Guidance
n/a
Referenced Documents
n/a

Lighting Control Strategies	Control strategies implemented by a connected system to alter the lighting system performance, usually to reduce energy consumption	
Minimum Requirement(s) The system must have the capability to implement all of the following lighting control strategies: <ul style="list-style-type: none">• Task tuning• Scheduling• Occupancy sensing• Daylight harvesting. The system must also be capable of manual control of lighting by a building occupant.	Possible Points n/a	
Method of Evaluation The Expert Reviewer Panel will review the manufacturer’s submitted system and component literature to verify compliance with the requirements. The Expert Reviewer Panel may test these capabilities in a laboratory setting to verify compliance.		
Materials to Submit by Competitor (M&I Phase) <ul style="list-style-type: none"><input type="checkbox"/> System and component literature including datasheets, and installation and configuration manuals<input type="checkbox"/> Instructions to Expert Reviewer Panel for how to demonstrate requirement.		
Supplemental Testing Guidance n/a		
Referenced Documents n/a		

System Resilience		The capability of the connected system to continue to function in the event of loss of connection to power, data network, and/or system controllers
Minimum Requirement(s) With a loss of connection to the internet, all lighting control strategies (task tuning, scheduling, occupancy sensing, daylight harvesting, and manual control) must continue to be implemented by luminaires and associated control devices in their pre-programmed state prior to loss of connection. With loss of connection to electrical power of up to 48 hours, and upon power reconnection, all lighting control strategies must continue to be implemented by luminaires according to their configuration prior to loss of connection.		Possible Points Fifteen points (+15) will be awarded to systems that maintain control strategy implementation with loss of connection to the next higher networked element in the system’s topology, such as a gateway.
Method of Evaluation The Expert Reviewer Panel will review the manufacturer’s submitted system and component literature to verify compliance with the requirements. The Expert Reviewer Panel may test these capabilities in a laboratory setting by disconnecting from the internet, network, and/or electrical power to verify system resilience.		
Materials to Submit by Competitor (M&I Phase) <div><input type="checkbox"/> System and component literature including datasheets, and installation and configuration manuals</div> <div><input type="checkbox"/> Instructions to Expert Reviewer Panel for how to demonstrate requirement.</div>		
Supplemental Testing Guidance n/a		
Referenced Documents n/a		

Appendix B: Connected Systems Track Technical Requirements

Fault Detection and Diagnostics (FDD)	The capability of the connected system to identify and diagnose faults and deliver notifications to operators about those faults
<p>Minimum Requirement(s)</p> <p>The lighting system must have the capability to identify and report faults in the system including but not limited to device/equipment errors and loss of network communication. Methods must be provided for automatic notification of faults to building operators. Notification must occur within 60 minutes of the fault.</p>	<p>Possible Points</p> <p>Eight points (+8) will be awarded for systems that leverage the data provided by D4i drivers to detect and report specific faults including, at a minimum, LED array/module failure, LED driver failure, compromised performance (e.g., reduced light level, and/or strobing light output) resulting from electrical power faults (over/under voltage and/or current), and electrical service interruption. The methods to detect and report these faults must be described.</p> <p>Seven additional points (+7) will be awarded for systems that can report remaining life for LED modules/boards and LED drivers, detect and diagnose the cause of LED array/module and LED driver failures (e.g., normal wear-out; accelerated wear-out due to high temperature, electric power faults), and predict potential faults so as to facilitate group or preventative maintenance.</p>
<p>Method of Evaluation</p> <p>The Expert Reviewer Panel will review the manufacturer's submitted system, component literature, and user interface to verify compliance with the requirements. The Expert Reviewer Panel may test these capabilities in a laboratory setting to verify compliance.</p>	
<p>Materials to Submit by Competitor (M&I Phase)</p> <ul style="list-style-type: none"> <input type="checkbox"/> System and component literature including datasheets, and installation and configuration manuals <input type="checkbox"/> Instructions to Expert Reviewer Panel for how to demonstrate requirement. 	
<p>Supplemental Testing Guidance</p> <p>n/a</p>	
<p>Referenced Documents</p> <p>n/a</p>	

Standards-Based Luminaire Level Lighting Control (LLLC)	A connected sensing/communication module with occupancy and ambient light sensing capabilities that can be directly installed into each luminaire through a standards-based Zhaga Book 20 or NEMA LS 20000-2021 sensor receptacle (shapes RR1, RR2, CC1, CC3, ORC5, or EM1) and connected to a standards-based D4i-certified driver
<p>Minimum Requirement(s)</p> <p>The connected system must provide a sensing/communication module that can be physically installed into a luminaire through a Zhaga Book 20 compliant sensor receptacle or a NEMA LS 20000-2021-compliant sensor receptacle (shapes RR1, RR2, CC1, CC3, ORC5, or EM1). The sensing/communication module must be D4i certified and directly connect to the DALI-bus terminals of a D4i-certified LED driver via a 2-wire connection. The sensing/communication module must, at minimum, provide occupancy and ambient light sensing capabilities.</p>	<p>Possible Points</p> <p>n/a</p>
<p>Method of Evaluation</p> <p>The Expert Reviewer Panel will review the submitted sensing/communication module(s), literature, and user interface to verify that the sensing/communication module provides occupancy and ambient light sensing capabilities. The Expert Reviewer Panel may test the installed system in a laboratory setting.</p> <p>The Expert Reviewer Panel will verify that the sensing/communication module is compliant with D4i by checking that the module is listed in the certified products list at https://www.dali-alliance.org/products.</p>	
<p>Materials to Submit by Competitor (M&I Phase)</p> <ul style="list-style-type: none"> <input type="checkbox"/> Sensing/communication module literature including any datasheets and installation manuals available <input type="checkbox"/> Link or documentation showing D4i sensor certification. 	
<p>Supplemental Testing Guidance</p> <p>n/a</p>	
<p>Referenced Documents</p> <ul style="list-style-type: none"> • D4i • Zhaga Book 20 	

Appendix B: Connected Systems Track Technical Requirements

- [NEMA LS 20000-2021: Physical Interface of Luminaire-Integrated Control Devices](#)
- [IEC 62386-101 Ed. 2.1 b:2018: Digital Addressable Lighting Interface – Part 101: General Requirements – System Components](#)
- [IEC 62386-103 Ed. 1.1 b:2018: Digital Addressable Lighting Interface – Part 103: General Requirements – Control Devices](#)
- [DALI Part 351 – Luminaire-mounted Control Devices](#)

Grid Services Capable		The capability of the connected system to provide grid services including load shed and load modulation	
Minimum Requirement(s) The system must be able to temporarily reduce the power demand of the lighting system in response to a signal (i.e., from a utility) without manual intervention. The method for configuring the system response shall facilitate the specification of a change in power relative to the current power or lighting level and be accessible through a user interface and be specifically described. The system must be OpenADR 3.0 compliant.		Possible Points Eight points (+8) will be awarded for systems that have the capability to configure the system to respond to an OpenADR 3.0 price signal with a varying system response at different price levels. The method for configuring the system response must be accessible through a user interface and be specifically described. Seven additional points (+7) will be awarded for systems that include configuration features to facilitate meeting/maintaining occupant needs in the event of a grid services/demand response event. The system must include a configurable ramp rate and the ability to define spaces that will 1) always respond, 2) respond conditionally, and 3) never respond to a grid services/demand response event. Conditional responses must include, at a minimum, occupancy and daylight inputs. The method for configuring the system response must be accessible through a user interface and be specifically described.	
Method of Evaluation The Expert Reviewer Panel will review the manufacturer’s submitted system, component literature, and user interface to verify compliance with the requirements, and will verify OpenADR certification listing on the OpenADR website. The Expert Reviewer Panel may test these capabilities in a laboratory setting to verify compliance.			
Materials to Submit by Competitor (M&I Phase) <div><input type="checkbox"/> System and component literature including datasheets, and installation and configuration manuals</div> <div><input type="checkbox"/> Instructions to Expert Reviewer Panel for how to demonstrate requirement</div>			
Supplemental Testing Guidance Relative power means relative to the current power level. For example, if luminaire power is currently set to 80%, then if the grid signal is to reduce the power by 30%, then the luminaire shall reduce its power draw from 80% down to 56% [80% * (100% – 30%) = 56%].			
Referenced Documents <div><ul style="list-style-type: none">OpenADR 3.0 Specifications</div>			

2. Product Life Cycle Requirements

Life Cycle and Sustainability Innovation	Innovations that support positive environmental impacts such as improved product circularity, reduced embodied carbon, improved end-of-life outcomes, reductions in the use and extraction of harmful materials, and/or improved material transparency ¹³	
Minimum Requirement(s) No minimum requirement	Possible Points Up to ten points (+10) will be awarded for successful submission and documentation addressing the high-level goals and the submission requirements outlined below.	
	Method of Evaluation DOE is looking for essay-style summaries or descriptions and documentation describing the specific life cycle problems or issues that were addressed, how these problems or issues were discovered or researched, the solution, and any iterations that were of interest in the process of arriving at the final solution. The submitted documentation will be judged by the Expert Reviewer Panel based on the quality of the content, approach, and arguments, and the scoring statement and scoring approach that are detailed in the following text.	

¹³ Material transparency refers to the disclosure of the ingredients and processes used to create materials or products, and their potential human health effects, environmental impacts, or social equity in manufacturing and recycling or disposal.

Appendix B: Connected Systems Track Technical Requirements

<p>The Expert Reviewer Panel will score the following statement:</p> <p>The competitor submitted a narrative or documentation that showed a clear life cycle and sustainability need, and thoughtful and considered innovation that supports positive environmental impacts such as improved product circularity, reduced embodied carbon, improved end-of-life outcomes, reductions in the use and extraction of harmful materials, and/or improved material transparency. Innovation claims are based on research and data, and the competitor is able to show actual or planned impact that is measurable.</p>	<p>Scoring Approach:</p> <p><u>Scored 0 to 10</u></p> <p>0 = strongly disagree or no submission 2 = disagree 4 = slightly disagree 6 = slightly agree 8 = agree 10 = strongly agree</p>
<p>Materials to Submit by Competitor (M&I Phase)</p> <p>□ Up to two-page PDF narrative describing positive environmental impacts such as improved product circularity, reduced embodied carbon, improved end-of-life outcomes, reductions in the use and extraction of harmful materials, and/or improved material transparency (optional).</p>	
<p>Supplemental Testing Guidance</p> <p>The goal of this requirement is to (1) improve product circularity, (2) reduce embodied carbon, (3) improve end-of-life outcomes, (4) reduce the use and extraction of harmful materials, and (5) improve material transparency. Sustainable connected systems support the needs of people for the equitable benefit of society and the environment. Life cycle and sustainability innovations should support one or more of these high-level goals, demonstrating sustainability impact on life cycle aspects such as materiality, carbon, and climate impacts associated with the sourcing, manufacturing, packaging, transportation, installation, operation, and disposal of equipment. Life cycle innovations could encompass the concept of the “triple bottom line”—addressing economic, societal, and environmental impacts—and the circular economy by designing out waste and pollution, keeping products and materials in use, and regenerating natural systems. Some examples (not inclusive) may include:</p> <ul style="list-style-type: none"> • Innovations that address the embodied carbon impacts of the connected system (narrative must include data or calculations to support claimed embodied carbon reductions or approaches) • Innovations that use recycled, biodegradable, or low-toxicity materials • Innovations that identify and/or reduce the use of harmful materials, for example using the International Living Future Institute Declare or Red List • Innovations that restore, renew, or revitalize their own sources of energy and materials • Innovative approaches to quantifying material sustainability impacts and/or communicating these to end-users • Innovations that reduce recovery processes (shredding) and increase recycling processes • Innovations that allow the connected systems to better integrate with new installation models such as Energy-as-a-Service (EaaS) and Lighting-as-a-Service (Laas) • Innovations that include labeling of parts, components, or other information systems to communicate end-of-life strategies • Innovations that utilize design for disassembly rules or approaches, for example (not inclusive): <ul style="list-style-type: none"> ○ Increasing material purity (e.g., avoiding adhesives, using joints or snap fits) ○ Reducing assembly and disassembly times (e.g., design for use of standard tools, use labelling, identifying separation points, minimizing the number and variety of materials used) 	
<p>Helpful Resources</p> <ul style="list-style-type: none"> • https://living-future.org/biophilic-design/ • https://living-future.org/red-list/ • https://living-future.org/declare/ • https://living-future.org/lpc/ • European Union. 2008. DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. Brussels: EU. • U.S. EPA, United States Environmental Protection Agency. n.d. Waste Management Hierarchy and Homeland Security Incidents. U.S. EPA. Accessed June 17, 2022. https://www.epa.gov/homeland-security-waste/waste-management-hierarchy-and-homeland-security-incidents. • Lienig, Jens, and Hans Bruemmer. 2017. Fundamentals of Electronic Systems Design. Cham, Switzerland: Springer. • Crowther, Philip. 2005. “RAIA/BDP Environment Design Guide: Design for Disassembly – Themes and Principles.” Brisbane: RAIA/BDP. • MacArthur F. 2013. “The Art of Design for Disassembly,” the Ellen MacArthur Foundation. 	

Labeling and Markings		Product labels or markings that provide information about servicing, disassembly, and recycling
Minimum Requirement(s) The major components of the connected system including gateways, switches, sensors, and interfaces shall include labeling or markings on or embedded in the components that lead to the manufacturer’s website for detailed instructions and guides to support servicing, disassembly, and end-of-life.	Possible Points n/a	
Method of Evaluation The Expert Reviewer Panel will review connected system component labels and markings to verify that they meet minimum requirements.		

¹⁴ Some examples of biodegradable components may include biodegradable circuit boards, or biopolymers used in additive (3D) printing, but there are many other examples not listed. See definitions from the [United States Department of Agriculture](#) and the [United States Environmental Protection Agency Science Inventory](#).

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Materials to Submit by Competitor (M&I Phase) <input type="checkbox"/> n/a
Supplemental Guidance The labels or markings shall direct users to a website hosted by the manufacturer that includes at minimum the following information: <ul style="list-style-type: none"> Who can service or modify the connected system component(s) (e.g., qualifications) What tools are required Servicing instructions Safety implications (e.g., like voiding UL listing/avoiding shock) What parts are modular/replaceable/serviceable (if any) Recycling codes (if applicable) Disassembly diagram (if component can be disassembled) including: <ul style="list-style-type: none"> Disassembly instructions Identification of parts by materials and recycling information including recycling codes (if available)
Helpful Resources <ul style="list-style-type: none"> CIBSE, 2021. TM66 Creating a circular economy in the lighting industry (2021) Hickcox and Smith, 2022. Strategies for achieving circular economy goals in the lighting industry through design for disassembly-based methodologies

3. Technical Innovation

Technical Innovation		Technical innovation that is beyond the prescriptive minimum requirements and associated points	
Minimum Requirement(s) No minimum requirement		Possible Points Up to fifty points (+50) will be awarded for technical innovation as scored by the Expert Reviewer Panel.	
Criterion: Ease of Installation and Use	The Expert Reviewer Panel will score the following statement: The system includes impactful innovations that simplify and/or improve the ease of installing, configuring, operating, and/or maintaining a connected lighting system beyond the typical practices and capabilities of today’s connected lighting systems.	Scoring Approach: Each Criterion Scored 0 to 10 0 = strongly disagree or no submission 2 = disagree 4 = slightly disagree 6 = slightly agree 8 = agree 10 = strongly agree	
Criterion: Compatibility and Interoperability	The Expert Reviewer Panel will score the following statement: The system includes impactful innovations that improve the compatibility and/or interoperability of connected lighting systems with other lighting and/or nonlighting devices and systems beyond the minimum L-Prize “Technical Interoperability” and “Application Interoperability” requirements, and beyond the typical practices and capabilities of today’s connected lighting systems.		
Criterion: Scalability	The Expert Reviewer Panel will score the following statement: The system includes impactful innovations that allow for deployment in a wide range of building sizes and types, with varying levels of customer sophistication and budgets, and with the ability to scale-up or improve installations, capabilities, and features over time.		
Criterion: Affordability and Value Proposition	The Expert Reviewer Panel will score the following statement: The system includes impactful innovations that reduce the up-front cost, improve the ability of users to afford it, and/or improve the value proposition beyond today’s connected lighting systems.		
Criterion: Health and Wellbeing	The Expert Reviewer Panel will score the following statement: The connected system includes impactful and science-backed innovations that can improve the health and/or wellbeing of students, workers, and/or other building occupants.		
Method of Evaluation The Expert Reviewer Panel will review materials submitted by the competitor and conduct a physical evaluation of the installed system. The Expert Reviewer Panel will then score the four statements shown previously in this table.			
DOE is seeking innovation that addresses current market or technology opportunities and barriers and that will lead to increased adoption of connected lighting systems by all users. Some examples (not inclusive) are:			
<ul style="list-style-type: none">• Innovations that simplify connected lighting system installation, configuration, and/or commissioning• Innovations that improve compatibility and/or interoperability with other lighting systems and nonlighting devices and systems• Innovations that simplify and/or improve ease of use of connected lighting systems for users, including building occupants and facility managers• Innovations that improve the ability to identify and diagnose problems that may occur during a connected lighting system installation• Innovations that improve the ability to diagnose and/or repair operational or performance problems that may occur over time			

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<ul style="list-style-type: none"> Innovations that improve the upgradeability or improve the upgrade process of connected lighting system components and systems such as firmware upgrades Innovations that improve the value proposition of connected lighting systems for building owners and decisionmakers with clearly articulated and quantified value Scalable approaches that can reduce potential retrofit costs and can accommodate future expansions Innovations that reduce the cost or improve the affordability of connected lighting systems for a wide range of users, including small buildings/businesses, disadvantaged communities, and those with limited budgets Innovations that allow for products to be packaged for different building sizes, types, and varying levels of customer sophistication and budget Innovations that are supported by science and data that may improve the health or wellbeing of people that work in or occupy rooms in which the connected systems are installed. Innovations should go beyond what is traditionally available with today's commercially available connected systems.
Materials to Submit by Competitor (M&I Phase): <ul style="list-style-type: none"> Up to two-page PDF narrative describing any innovations beyond current practice that improve the ease of installing, configuring, operating, and/or maintaining the connected lighting system. The narratives should quantify the benefit as much as possible and include technical justifications or engineering analysis to support the claimed innovation. (optional) Up to two-page PDF narrative describing any innovations beyond current practice that improve the compatibility and/or interoperability of the connected lighting system with other lighting and/or nonlighting devices and systems. Narratives should specifically describe the potential use cases and value delivered by the innovation. (optional) Up to two-page PDF narrative describing any impactful innovations that allow for deployment in a wide range of building sizes and types; varying levels of customer sophistication and budget; and the ability to scale-up or improve installations, capabilities, and features over time (e.g., start small and build up over time as users get more resources). (optional) Up to two-page PDF narrative describing any innovations that improve the value proposition and cost-effectiveness, or that reduce the cost of the connected system relative to currently available connected systems. Narratives must include estimated distributor net pricing information for a quantity of 20 sensing/communication modules, 20 switches, and 2 gateways. Competitors should quantify how the connected system design innovations and pricing improves the affordability and value proposition compared to currently available connected systems. (optional) Up to two-page PDF narrative describing any innovations that can improve the health and/or wellbeing of students, workers, or other building occupants that work or occupy rooms in which the luminaire is installed. The narrative must include the scientific basis, data, and associated citations for any health and wellbeing benefit claims. (optional)
Supplemental Testing Guidance n/a
Referenced Documents n/a

4. U.S. Content, Production, and Installation

U.S. Content		The U.S. content of connected system components or subcomponents	
Minimum Requirement(s) No minimum requirement		Possible Points Up to fifteen points (+15) will be awarded for systems that demonstrate significant U.S. content by manufacturing and/or assembling components or subsystem components in the United States.	
Criterion: U.S. Content	The Expert Reviewer Panel will score the following statement: The competitor’s connected system includes significant U.S. content by manufacturing and/or assembling components or subsystem components in the United States.	Scoring Approach: <u>Scored 0 to 15</u> 0 = strongly disagree or no submission 5 = disagree 10 = agree 15 = strongly agree	
Method of Evaluation The Expert Reviewer Panel will review the competitor’s submitted documentation of U.S. content, if any.			
Materials to Submit by Competitor <ul style="list-style-type: none">U.S. Content Narrative—Up to two-page narrative in PDF format that includes at minimum:<ul style="list-style-type: none">A bill of materials of all connected system components and their associated country of originThe location, facilities description, and capabilities where any U.S. assembly or manufacturing occurs (DOE may visit the assembly or manufacturing site)A step-by-step description of the U.S. manufacturing or assembly processAny additional U.S. content to be considered by the Expert Reviewer Panel, such as U.S. sourcing, manufacturing, and/or assembly of materials, components, or subcomponents.			
Supplemental Testing Guidance n/a			
Referenced Documents <ul style="list-style-type: none">n/a			

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Production and Deployment Plan		The capabilities and plan to manufacture and deploy the connected systems in commercial buildings	
Minimum Requirement(s) The competitor must provide a documented plan that describes the competitor’s capabilities and strategy to manufacture the connected system and a go-to-market strategy to deploy the connected system to large numbers of commercial buildings. The plan must address all points listed in the Supplemental Guidance section subsequently in this table.		Possible Points Up to fifteen points (+15) will be awarded for the quality, credibility, and responsiveness of the production and deployment plan documenting production capabilities and effective go-to-market strategies.	
Criterion: Production and Deployment Plan	The Expert Reviewer Panel will score the following statement: The competitor submitted a well-documented, comprehensive, credible plan that demonstrates significant capabilities to manufacture the connected system in large quantities and an effective go-to-market strategy that will deploy the connected system to large numbers of commercial buildings.	Scoring Approach: <u>Scored 0 to 15</u> 0 = strongly disagree or no submission 5 = disagree 10 = agree 15 = strongly agree	
Method of Evaluation The Expert Reviewer Panel will review the competitor’s Production and Deployment Plan to check that the minimum requirement is met. The submitted documentation will be judged by the Expert Reviewer Panel based on the quality, credibility, and responsiveness of the plan to demonstrate significant capabilities to manufacture and deploy the luminaire to large numbers of commercial buildings. DOE may visit the manufacturing/assembly site to verify what is described in the plan.			
Materials to Submit by Competitor <input type="checkbox"/> Production and Deployment Plan.			
Supplemental Guidance The Production and Deployment Plan should, at minimum, include the following information: <ul style="list-style-type: none">• How and where the connected system is manufactured and assembled, including subsystem components• How many connected system components are expected to be produced, production capacity limits, and description of the variables that impact production amounts and limits• A quality control plan to ensure high quality manufacturing and products• A go-to-market strategy that will result in significant quantities of the connected system being deployed in commercial buildings. The go-to-market strategy should include, at minimum, information to answer the following questions: <ul style="list-style-type: none">○ What is (are) the target market(s) for the system? Provide characteristics of the target market(s) including size and sales or adoption potential.○ What is the foreseen volume over 1, 3, and 5 years?○ What are the key value propositions? What problems is the connected system solving or what new values is it providing?○ What are the key adoption hurdles, and how will they be addressed? For example, if the connected system is expected to have a significant price premium that may inhibit sales or adoption, how will this challenge be addressed?○ What channels and methods will be used to deploy the connected system to the target market?○ How will the connected system be marketed? What are the key messages and methods?			
Referenced Documents <ul style="list-style-type: none">• n/a			

U.S. Installation		A real installation of the connected system at a commercial or institutional facility located in the United States	
Minimum Requirement(s) The competitor must document at least one U.S. installation of the connected system that can be physically visited by DOE. The installation must be in one of the targeted applications of the L-Prize as described in section I.3: TARGETED APPLICATIONS, SYSTEMS, AND LUMINAIRE TYPES . The installation must include control of at least 20 luminaires by the system and be able to demonstrate the following capabilities: <ul style="list-style-type: none"> Addressability All strategies of the Lighting Control Strategies requirement, including manual on/off/dim capabilities Energy reporting Fault detection and diagnostics (basic system faults only) Luminaire Level Lighting Control. The installation must utilize the commercially available and manufactured connected system that was submitted for entry, and should not utilize any prototype components. The installation site must not be one of the competitor's own facilities or directly affiliated with the competitor. DOE and the Expert Reviewer Panel may visit the site(s) to observe, document, and confirm the installations.		Possible Points Fifteen points (+15) will be awarded for installation sites where the lighting system is integrated with the HVAC system and lighting system occupancy or other data is used to optimize HVAC operation for energy savings benefits.	

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Method of Evaluation The Expert Reviewer Panel will review the competitor's submitted documentation and may visit the installation site. Successfully meeting the minimum requirement means that the submitted documentation includes all requested information and that the Connected System is successfully installed and functioning and demonstrates all required capabilities listed in the minimum requirement.
Materials to Submit by Competitor <ul style="list-style-type: none"> <input type="checkbox"/> A site installation document must be provided in PDF format that includes the following: <ul style="list-style-type: none"> ○ Contact information for the owner or manager (or other appropriate representative) at the installation site ○ A reflected ceiling plan (RCP) showing luminaire locations and controls ○ A project reflected ceiling plan (RCP) showing luminaire locations and connected system components ○ A documented control narrative and sequence of operations of the system ○ Construction permit compliance documentation ○ Description of lighting system and HVAC integration including integration method (e.g., API, BACnet), what data is exchanged between the systems, and how this data optimizes HVAC operation for energy savings benefits (optional).
Supplemental Guidance DOE will take and publicize photos of the installation site(s), but will not identify the site name, owner, and location(s) without appropriate permissions. In selecting their installation site, competitors must ensure site owners will allow at minimum anonymized photos of the installations to be publicized. DOE may seek ongoing feedback and evaluation from the site and may develop a case study should the host site agree to participate. This ongoing feedback, evaluation, and case study development are not within the scope of the M&I Phase and would be negotiated with the competitor and host site owner following the completion of the M&I Phase.
Referenced Documents <ul style="list-style-type: none"> • n/a

Commercial Availability		The commercial availability of the connected system including complete product literature and marketing materials	
Minimum Requirement(s) The connected system must be fully commercially available for purchase with complete, final documentation and literature readily available on the manufacturer’s website. The connected system components must all be certified with all appropriate electrical and fire safety certifications.		Possible Points n/a	
Method of Evaluation The Expert Reviewer Panel will review the competitor’s website, marketing materials, and product literature.			
Materials to Submit by Competitor <ul style="list-style-type: none">□ Location of product website listing and spec sheets, marketing materials, installation guides, and other relevant system documentation to indicate full commercial availability□ Documentation demonstrating appropriate safety certifications of the connected system components from a recognized safety certification body such as UL, CSA, or ETL.			
Supplemental Guidance Draft materials may be submitted initially and evaluated by the Expert Reviewer Panel. However, the final determination and announcement of the award will not be made until final materials are made available on a publicly available website.			
Referenced Documents <ul style="list-style-type: none">• n/a			

APPENDIX C: Testing Laboratory and Reporting Requirements

LM-79 Testing and Reporting Requirements

ANSI/IES LM-79-19 testing must be conducted, and reports must be issued, by a testing laboratory with a current accreditation from the [National Institute of Standards and Technology \(NIST\), National Voluntary Laboratory Accreditation Program \(NVLAP\)](#).

Laboratories with accreditation other than NVLAP may be acceptable if the following requirements are met:

1. The accreditation body must have a Mutual Recognition Arrangement (MRA) in place with international oversight traceable to the [International Laboratory Accreditation Cooperation \(ILAC\)](#). Proof of this agreement must be provided.
2. A document describing the LM-79 accreditation process must be published or provided by the accreditation body.
3. A document describing the experience and competence of the quality assessor teams for LM-79 accreditation with regard to absolute photometry and solid-state lighting (SSL) testing must be provided. This includes competencies listed in section 2.2.3 of the ILAC Guidelines on Qualifications and Competence of Assessors and Technical Experts, articles 2.2.3.1 and 2.2.3.2, concerning estimation of measurement uncertainties and analysis of proficiency testing needs and results.

The DesignLights Consortium (DLC) maintains a [current list of laboratories with these accreditations](#).

LM-79 test reports must include the following information:

- Electrical characteristics (wattage, input voltage, THD, and PF)
- Total luminous flux
- Luminous intensity distribution (candela array)
- Efficacy
- Chromaticity ((x,y) and (u'v'))
- CCT and Duv
- ANSI/IES TM-30-20 Full Report (per Annex D, Figure D-3) (although it is preferred to provide this report as part of the larger LM-79 report, it is also permissible to provide the TM-30-18 report separately)
- CIE 13.3-1995 complete Color Rendering Index detail
- .IES file (ANSI/IES LM-63-19) meeting the following requirements:
 - Test report number, test lab, issue date, manufacturer, and luminaire catalog number are correctly indicated using the keywords [TEST], [TESTLAB], [ISSUEDATE], [MANUFAC], and [LUMCAT], respectively.
 - The multiplier field must only be 1.0 (i.e., the candela values must be from an actual goniophotometer test, and scaled values are not permitted).
 - The luminous intensity data shall be presented using Type C photometry format.
 - The luminous dimensions must appropriately reflect the luminous opening of the luminaire. See the Supplemental Testing Guidance section of the [Glare Control requirement](#) for more information regarding determining the luminous area.
 - The angular resolution for the luminous intensity distribution data must comply with the scanning resolution specified in section 7.3.3 in LM-79-19 and be fine enough to accurately characterize the product's intensity distribution. For products with a wide-angle, smooth intensity distribution, the luminous intensity distribution data must be in a resolution of 5 degrees or less in the vertical plane and 22.5 degrees or less in horizontal planes. A smaller vertical angular increment must be used for products whose luminous intensity changes rapidly as a function of angle.

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- Accompanying .SPDX document (IES TM-27-20) and XML document (IES TM-33-18) with spectral power distribution data from 380 to 780 nm in ≤ 5 nm increments. The product model number must be present and match in both the TM-27 and LM-79 documents.

Test reports containing only a partial set of LM-79 metrics (for example, an integrating sphere test report without luminous flux reported) will be considered incomplete.

LM-80 Testing and Reporting Requirements

ANSI/IES LM-80-20 testing must be conducted by, and reports must be issued by, an accredited testing laboratory for the test being conducted. Additionally, LM-80 test results will only be accepted from laboratories listed as [approved Energy Star LM-80 testing laboratories](#).

ISTMT Testing and Reporting Requirements

In Situ Temperature Measurement Test (ISTMT) results must be from a laboratory meeting at least one of the following requirements:

- Approved by the Occupational Safety and Health Administration (OSHA) as a Nationally Recognized Testing Laboratory (NRTL) [List of OSHA NRTLs](#)
- Approved through an OSHA NRTL data acceptance program or OSHA Satellite Notification and Acceptance Program (SNAP)
- Accredited for ANSI/UL 1598 or CSA C22.2 No. 250.0-08, including sections 19.7, 19.10-16, by an accreditation organization that is an ILAC MRA signatory.

These requirements are applicable for laboratories conducting both LED ISTMTs and driver ISTMTs.

UL 1598 testing may be used for the ISTMT report if the lab that conducted the test meets the laboratory requirements for ISTMT.

APPENDIX D: Submission Documentation Checklist

1. LUMINAIRE TRACK CHECKLIST

Category	Submission Item(s)	L-Prize Technical Requirement(s)
General	<input type="checkbox"/> Cover page, which may be released to the public by DOE <input type="checkbox"/> PowerPoint summary slide, which may be released to the public by DOE <input type="checkbox"/> Images of the luminaire, design and manufacturing teams, manufacture or assembly, and installation site, which may be released to the public by DOE <input type="checkbox"/> Completed M&I Phase Technical Performance and Scoring Form <input type="checkbox"/> Description of key innovations and features <input type="checkbox"/> Three complete working physical luminaires.	<ul style="list-style-type: none"> More information is available in Section IV.5.
Efficacy	<input type="checkbox"/> ANSI/IES LM-79 test report at 100% light output. <input type="checkbox"/> Power supply testing report <i>(only for luminaires with remote power supplies, including low-voltage DC and PoE systems)</i>	<ul style="list-style-type: none"> Luminaire Efficacy
Quality of Light	<input type="checkbox"/> ANSI/IES LM-79 test report at 100% light output.	<ul style="list-style-type: none"> Light Output Color Rendition Chromaticity Glare Control Dimming Range
	<input type="checkbox"/> Full ANSI/IES TM-30 report as specified in TM-30 Annex E.	<ul style="list-style-type: none"> Color Rendition
	<input type="checkbox"/> .SPDX file in accordance with IES TM-27-20.	<ul style="list-style-type: none"> Color Rendition Spectral Power Data
	<input type="checkbox"/> .IES file in accordance with ANSI/IES LM-63 <input type="checkbox"/> Documented determination of luminous area based on guidance from LM-63 and DLC <input type="checkbox"/> Tabular method corrected UGR table using values established in CIE 190:2010 <input type="checkbox"/> Technical justification if UGR criteria is not met	<ul style="list-style-type: none"> Glare Control
	<input type="checkbox"/> ANSI/IES LM-90 test report with documentation of fundamental frequency at 100% light output <input type="checkbox"/> ANSI/IES LM-90 test report with documentation of fundamental frequency at 50% light output <input type="checkbox"/> ANSI/IES LM-90 test report with documentation of	<ul style="list-style-type: none"> Temporal Light Modulation (TLM, aka “flicker” waveform)

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	fundamental frequency at minimum dimmed light output	
	<input type="checkbox"/> ANSI/IES LM-79 test report at the minimum dimmed light output	<ul style="list-style-type: none"> Dimming Range
Connectivity	<input type="checkbox"/> Driver literature including datasheets and installation manuals <input type="checkbox"/> Link or documentation showing D4i driver certification	<ul style="list-style-type: none"> Standards-Based Digital Driver
Product Life Cycle	<input type="checkbox"/> Verified TM66 Assured Product Verification certificate from the Lighting Industry Association (LIA) <input type="checkbox"/> Completed TM66 CEAM tool	<ul style="list-style-type: none"> Circular Design
	<input type="checkbox"/> Verified life cycle assessment (LCA) including documentation of the verification <input type="checkbox"/> Accompanying environmental product declaration (EPD)	<ul style="list-style-type: none"> Life Cycle Assessment
	<input type="checkbox"/> Up to two-page PDF narrative describing material transparency and material health innovations (optional)	<ul style="list-style-type: none"> Materials and Sustainability Innovation
	<input type="checkbox"/> ANSI/IES LM-80 test report <input type="checkbox"/> ISTMT test report <input type="checkbox"/> ANSI/IES TM-21-21 calculation	<ul style="list-style-type: none"> Lumen Maintenance
	<input type="checkbox"/> ANSI/IES LM-80-20 test report for each LED type used	<ul style="list-style-type: none"> Chromaticity Maintenance
	<input type="checkbox"/> Driver ISTMT test report <input type="checkbox"/> Photographic documentation of the actual thermocouple applied to the temperature measurement point with an arrow indicating the thermocouple attachment point <input type="checkbox"/> Datasheet or documentation from the driver manufacturer that indicates the maximum case temperature for which the driver is designed to last $\geq 50,000$ hours, as well as the TMP location it designates for thermal testing	<ul style="list-style-type: none"> Driver Lifetime
Technical Innovation	<input type="checkbox"/> Up to two-page PDF narrative describing any innovations beyond luminaire efficacy that improve the application efficiency of the luminaire. The narratives should quantify the application efficiency benefit and include technical justifications or engineering analysis to support the claimed innovation (optional). <input type="checkbox"/> Up to two-page PDF narrative describing any innovations in form factor and aesthetics that will	<ul style="list-style-type: none"> Technical Innovation

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	<p>improve the acceptability and adoptability of the solution. Narratives should specifically describe the problem or opportunity that the aesthetic or form factor innovation addresses and include any supporting data or analysis to quantify the potential benefit in terms of adoptability, as feasible (optional).</p> <ul style="list-style-type: none"> <input type="checkbox"/> Up to two-page PDF narrative describing any impactful innovations that will improve the ease of installation and/or standardization of installation, both of which can lead to wider adoption of energy technologies (optional). <input type="checkbox"/> Up to two-page PDF narrative describing any innovations that improve the value proposition and cost-effectiveness or reduce the cost of the luminaire relative to currently available luminaires. Narratives should quantify the value or cost benefit with supporting analysis and/or technical justification (optional). <input type="checkbox"/> Up to two-page PDF narrative describing any innovations that can improve the health and/or wellbeing of students, workers, and/or other building occupants (optional) 	
U.S. Content, Production, and Installation	<ul style="list-style-type: none"> <input type="checkbox"/> U.S. Content Narrative—Up to two-page narrative in PDF format that includes at minimum: <ul style="list-style-type: none"> ○ A bill of materials for all components within the luminaire and their associated country of origin ○ The location, facilities description, and capabilities where the luminaire is assembled (DOE may visit the luminaire assembly site) ○ A step-by-step description of the assembly process ○ Any additional U.S. content to be considered by the Expert Reviewer Panel, such as U.S. sourcing; manufacturing; and/or assembly of materials, components, or subcomponents beyond the final luminaire assembly. 	<ul style="list-style-type: none"> • U.S. Content
	<ul style="list-style-type: none"> <input type="checkbox"/> Production and Deployment Plan 	<ul style="list-style-type: none"> • Production and Deployment Plan
	<ul style="list-style-type: none"> <input type="checkbox"/> A site installation document must be provided in PDF format that includes the following: <ul style="list-style-type: none"> ○ Contact information for the owner or manager (or other appropriate 	<ul style="list-style-type: none"> • U.S. Installation

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	<ul style="list-style-type: none"> representative) at the installation site ○ A reflected ceiling plan (RCP) showing luminaire locations and control(s) ○ A luminaire schedule showing quantities and luminaire specifications ○ Energy code compliance documentation in the form of a COMcheck report that quantifies the lighting power density of the installed applications ○ Construction permit compliance documentation 	
	<ul style="list-style-type: none"> <input type="checkbox"/> Location of product website listing and spec sheets, marketing materials, installation guides, and other relevant product documentation to indicate full commercial availability <input type="checkbox"/> Documentation demonstrating appropriate safety certifications of the luminaire from a recognized safety certification body such as UL, CSA, or ETL 	<ul style="list-style-type: none"> • Commercial Availability

2. CONNECTED SYSTEMS TRACK CHECKLIST

Category	Submission Item(s)	L-Prize Technical Requirement(s)
General	<ul style="list-style-type: none"> <input type="checkbox"/> Cover page, which may be released to the public by DOE <input type="checkbox"/> PowerPoint summary slide, which may be released to the public by DOE <input type="checkbox"/> Images of the connected system, design and manufacturing teams, manufacture or assembly, and installation site, which may be released to the public by DOE <input type="checkbox"/> Completed M&I Phase Technical Performance and Scoring Form <input type="checkbox"/> Description of key innovations and features <input type="checkbox"/> System one-line diagram <input type="checkbox"/> Instructions for Expert Reviewer Panel <input type="checkbox"/> Three complete working physical connected systems 	N/A
Connectivity	<input type="checkbox"/> Manufacturer documentation that identifies the industry standard or specification used for physical network connectivity	<ul style="list-style-type: none"> • Technical Interoperability
	<input type="checkbox"/> API documentation that includes all required information listed in the Application Interoperability requirement	<ul style="list-style-type: none"> • Application Interoperability

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	<input type="checkbox"/> BACnet certified product listing information (if applicable) <input type="checkbox"/> BACnet Protocol Implementation Conformance Statement (if applicable) <input type="checkbox"/> BACnet Object Table(s) (if applicable) <input type="checkbox"/> BACnet HVAC zone configuration instructions (if applicable)	
	<input type="checkbox"/> System and component literature including datasheets, and installation and configuration manuals <input type="checkbox"/> Instructions to Expert Reviewer Panel for how to demonstrate requirement	<ul style="list-style-type: none"> • Addressability • Energy Reporting • Lighting Control Strategies • System Resilience • Fault Detection and Diagnostics (FDD) • Grid Services Capable
	<input type="checkbox"/> Letter or certificate of compliance from third-party cybersecurity certification organization	<ul style="list-style-type: none"> • Cybersecurity
	<input type="checkbox"/> Sensing/communication module literature including any datasheets and installation manuals available <input type="checkbox"/> Link or documentation showing D4i sensor certification	<ul style="list-style-type: none"> • Standards-Based Luminaire Level Lighting Control (LLLC)
Product Life Cycle	<input type="checkbox"/> Up to two-page PDF narrative describing positive environmental impacts such as improved product circularity, improved end-of-life outcomes, reductions in the use and extraction of harmful materials, or improved material transparency (optional)	<ul style="list-style-type: none"> • Life Cycle and Sustainability Innovation
Technical Innovation	<input type="checkbox"/> Up to two-page PDF narrative describing any innovations beyond current practice that improve the ease of installing, configuring, operating, and/or maintaining the connected lighting system. The narratives should quantify the benefit as possible and include technical justifications or engineering analysis to support the claimed innovation (optional). <input type="checkbox"/> Up to two-page PDF narrative describing any innovations beyond current practice that improve the compatibility and/or interoperability of the connected lighting system with other lighting and/or nonlighting devices and systems. Narratives should	<ul style="list-style-type: none"> • Technical Innovation

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	<p>specifically describe the potential use cases and value delivered by the innovation (optional).</p> <ul style="list-style-type: none"> <input type="checkbox"/> Up to two-page PDF narrative describing any impactful innovations that allow for deployment in a wide range of building sizes and types; varying levels of customer sophistication and budget; and with the ability to scale-up or improve installations, capabilities, and features over time (e.g., start small and build up over time as users get more resources). <input type="checkbox"/> Up to two-page PDF narrative describing any innovations that improve the value proposition and cost-effectiveness, or reduce the cost of the connected system relative to currently available connected systems. Narratives should quantify the value or cost benefit with supporting analysis and/or technical justification (optional). <input type="checkbox"/> Up to two-page PDF narrative describing any innovations that can improve the health and/or wellbeing of students, workers, and/or other building occupants (optional) 	
U.S. Content, Production, and Installation	<ul style="list-style-type: none"> <input type="checkbox"/> U.S. Content Narrative—Up to two-page narrative in PDF format that includes at minimum: <ul style="list-style-type: none"> ○ A bill of materials of all connected system components and their associated country of origin ○ The location, facilities description, and capabilities where any U.S. assembly or manufacturing occurs (DOE may visit the assembly or manufacturing site) ○ A step-by-step description of the U.S. manufacturing or assembly process ○ Any additional U.S. content to be considered by the Expert Reviewer Panel, such as U.S. sourcing, manufacturing, and/or assembly of materials, components, or subcomponents. 	<ul style="list-style-type: none"> • U.S. Content
	<ul style="list-style-type: none"> <input type="checkbox"/> Production and Deployment Plan 	<ul style="list-style-type: none"> • Production and Deployment Plan
	<ul style="list-style-type: none"> <input type="checkbox"/> A site installation document must be provided in PDF format that includes the following: <ul style="list-style-type: none"> ○ Contact information for the owner or manager (or other appropriate representative) at the installation site ○ An RCP showing luminaire locations and controls ○ A project reflected ceiling plan (RCP) showing luminaire locations and connected system 	<ul style="list-style-type: none"> • U.S. Installation

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	<p>components</p> <ul style="list-style-type: none">○ A documented control narrative and sequence of operations of the system○ Construction permit compliance documentation○ Lighting and HVAC integration documentation (optional).	
	<ul style="list-style-type: none">□ Location of product website listing and spec sheets, marketing materials, installation guides, and other relevant system documentation to indicate full commercial availability□ Documentation demonstrating appropriate safety certifications of the connected system components from a recognized safety certification body such as UL, CSA, or ETL	<ul style="list-style-type: none">• Commercial Availability

APPENDIX E: Changes to M&I Phase Rules from Prior Published Draft Version

Overall Changes

- Point structure and amounts have been updated for most requirements across both tracks.
- Diversity, Equity, and Inclusion (DEI): DEI has been updated. In previous phases the L-Prize featured a separate DEI scoring category. This has been replaced with a holistic equity-focused approach throughout all of the technical and innovation categories through which equity, resilience, and accessibility criteria were updated or added. Also, existing points opportunities were increased for innovations that improve the adoptability of the solution for all communities and building types.
- Additional Life Cycle and Operation Considerations (LCOC): LCOC business model or contract innovations and associated opportunities have been removed as a category to focus on product level innovations.
- Images of the product, manufacturing process, design and/or manufacturing team, and installation are now required as part of the submission package.

Luminaire Track Changes

- Chromaticity: This rule was modified to allow Duv up to +0.002 and to require that LEDs are binned and selected such that any sample will fall within Duv requirements.
- Glare Control – An alternative compliance method was added so that a competitor can demonstrate excellent glare control despite not meeting the UGR ≤ 22 requirement.
- Temporal Light Modulation: SVM ≤ 0.4 is now a minimum requirement (no longer eligible for points).
- White Tunable: White-tunable luminaires with white-tuning capability implemented are now allowed but will be evaluated at 4000 K.
- Visual Comfort: A new scoring category was added that will be scored by the Expert Reviewer Panel.
- Circular Design: A verified TM66 Assured Product Verification certificate is required in addition to the completed tool.
- Life Cycle Assessment: A new requirement was added that calls for a verified life cycle assessment (LCA) and an accompanying environmental product declaration (EPD).
- Replaceable Components: A new minimum requirement has been added to require replaceable drivers and LED arrays/modules.
- Labeling and Markings: A new minimum requirement has been added to require labeling or markings that support on-site upgrades and better end of life outcomes by directing users to information about servicing, disassembly, and end-of-life instructions.
- Lumen Maintenance: The $L_{90} \geq 36,000$ hrs has been made a minimum requirement and is no longer eligible for points.
- Technical Innovation, Ease of Installation: A new category addressing equity and accessibility has been added for ease of installation of the luminaire and will be scored by the Expert Reviewer Panel.
- Technical Innovation, Affordability and Value Proposition: Cost-effectiveness and Value Proposition has been modified to Affordability and Value Proposition to better focus on innovations that improve the equity and accessibility of the luminaire for a wide range of buyers.
- Technical Innovation, Health and Wellbeing: A new category addressing health and wellbeing innovations has been added, to be scored by the Expert Reviewer Panel.
- U.S. Content: U.S. assembly is explicitly required and additional points to be earned will be scored by the Expert Reviewer Panel.

Appendix E: Changes to M&I Phase Rules from Prior Published Draft Version

- U.S. Installation: The requirement has been updated with additional information for site criteria, scope of evaluation, and submission requirements.

Connected Systems Track Changes

- Application Interoperability: The requirement has been modified to be clear about what data must be accessible through the API and how the data are to be retrieved. Additionally, a new requirement is added for submission of an OpenAPI specification document. Finally, up to 15 points are now offered for systems that are BACnet certified to support integration with BMS and HVAC systems.
- Cybersecurity: Cybersecurity is now required for the M&I phase and follows Designlights Consortium cybersecurity requirements for networked lighting control systems.
- Energy Reporting: The requirement has been modified to be clear that reporting of cumulative energy data is required.
- Standards-Based Luminaire Level Lighting Control (LLLC): D4i certification is now explicitly required.
- Grid Services Capable: The requirement has been modified to be clear that relative light level or power changes are required, and that OpenADR 3.0 is required rather than 2.0a.
- Labeling and Markings: A new minimum requirement has been added to require labeling or markings that direct users to information to support servicing, disassembly, and recycling or end-of-life instructions.
- Technical Innovation, Scalability: A new accessibility and equity-focused requirement has been added for scalability of the solution for different building sizes, types, and varying levels of customer sophistication and budget, to be scored by the Expert Reviewer Panel.
- Technical Innovation, Affordability and Value Proposition: Cost-effectiveness and Value Proposition has been modified to Affordability and Value Proposition to better focus on innovations that improve the equity and accessibility of the luminaire for a wide range of users.
- Technical Innovation, Health and Wellbeing: A new category addressing health and wellbeing innovations has been added, to be scored by the Expert Reviewer Panel.
- U.S. Installation: The requirement has been updated with additional information for site criteria, scope of evaluation, and submission requirements.

ADDITIONAL TERMS AND CONDITIONS

1. UNIVERSAL CONTEST REQUIREMENTS

Submissions to the L-Prize Concept, Prototype, and/or Manufacturing and Installation phases are subject to the following terms and conditions:

- Competitors must register at <https://www.herox.com/LPrize> to participate in the L-Prize.
- Final entries must be submitted online at <https://www.herox.com/LPrize> before the published deadlines for the relevant phases. Late submissions and/or any other forms of submission may be disqualified.
- The submitted cover page and summary slide submitted will be made public.
- Other than the cover page and summary slide, content of submissions is not intended to be made public; however, see [subsection 10](#) regarding the Freedom of Information Act.
- All required submission elements must be included. The Prize Administrator may disqualify a submission after an initial screening if it fails to provide all required submission elements.
- Submissions must be in English and in PDF format or readable by Microsoft Word. Scanned handwritten submissions will be disqualified.
- Submissions will be disqualified if they contain any matter that, in the sole discretion of the Prize Administrator, is indecent, obscene, defamatory, libelous, unprofessional, or disrespectful to people or life on this planet.
- If a competitor clicks “Accept” on the HeroX platform and proceeds to register for any of the contests described in this document, these rules will form a valid and binding agreement between the competitor and the U.S. Department of Energy that is in addition to the existing HeroX Terms of Use for all purposes relating to these contests. Competitors should keep a copy of these rules. These provisions only apply to the contests described here and no other contests on the HeroX platform or anywhere else.
- The Prize Administrator, when feasible, may give competitors an opportunity to fix nonsubstantive mistakes or errors in their submission packages.
- For the Prototype and Manufacturing and Installation phases, only one submission in each track will be accepted from a single lead organization and considered for a prize award.
- As part of your submission to this prize, you will be required to sign the following statement:
 - I am providing this submission package as part of my participation in this prize. I understand that the information contained in this submission will be relied on by the federal government to determine whether to issue a prize to the named competitor. I certify under penalty of perjury that the named competitor meets the eligibility requirements for this prize competition and complies with all other rules contained in the Official Rules document. I further represent that the information contained in the submission is true and contains no misrepresentations. I understand false statements or misrepresentations to the federal government may result in civil and/or criminal penalties under 18 U.S.C. § 1001 and § 287, and 31 U.S.C. §§ 3729-3733 and 3801-3812.

2. VERIFICATION FOR PAYMENTS

Additional Terms and Conditions

The Prize Administrator will verify the identity and the role of a competitor who is potentially qualified to receive a prize. Competitors are required to list the entity that would receive payment if selected in their HeroX submission as it appears on a W-9 form. Receiving a prize payment is contingent upon fulfilling all requirements contained herein. The Prize Administrator will contact winning competitors using the provided email contact information. Each competitor will be required to sign and return to the Prize Administrator, within 30 days of the date the notice is sent, a completed Prize Acceptance form, a completed NREL Request for ACH Banking Information form, and a completed W9 form (<https://www.irs.gov/pub/irs-pdf/fw9.pdf>). At the sole discretion of the Prize Administrator, a winning competitor will be disqualified from the competition and receive no prize funds if: (i) the person/entity cannot be contacted via the contact information provided; (ii) the person/entity fails to sign and return the required documentation within the required time period; (iii) the notification is returned as undeliverable; (iv) the submission or person/entity is disqualified for any other reason.

3. TEAMS AND SINGLE ENTITY AWARDS

The Prize Administrator will award a single dollar amount to the designated primary submitter (team leader) whether a team consists of a single entity or multiple entities. The primary submitter is solely responsible for allocating any prize funds among member competitors as they deem appropriate. The Prize Administrator will not arbitrate, intervene, advise on, or resolve any matters between team members.

4. SUBMISSION RIGHTS

By entering a submission and consenting to the rules of the contest, a competitor grants to DOE, the Prize Administrator, and any other third parties supporting DOE in the contest a license to display publicly and use the parts of the submission that are designated as “public” for governmental purposes. This license includes posting or linking to the public portions of the submission on the Prize Administrator’s or HeroX’s applications, on the contest website, DOE websites, and partner websites, and the inclusion of the submission in any other media worldwide. The submission may be viewed by the Prize Judge, the Prize Administrator, and Expert Reviewer Panel for purposes of the contests, including, but not limited to, screening and evaluation purposes. The Prize Administrator and any third parties acting on their behalf will also have the right to publicize competitors’ names and, as applicable, the names of competitors’ team members and organizations that participated in the submission on the contest website indefinitely.

Intellectual property developed by a competitor in the prize competition is owned by the competitor. The competitor, however, grants use rights to the government as described in this section, and to the extent that submissions are not marked, as described in Additional Terms and Conditions – Section 10.

5. COPYRIGHT

Each competitor represents and warrants that the competitor is the sole author and copyright owner of the submission; that the submission is an original work of the competitor or that the competitor has acquired sufficient rights to use and to authorize others, including the Prize Administrator, to use the submission, as specified throughout the official L-Prize rules; that the submission does not infringe upon any copyright or any other third-party rights of which the competitor is aware, or should be aware; and that the submission is free of malware.

6. CONTESTS SUBJECT TO APPLICABLE LAW

All contests are subject to all applicable federal laws and regulations. Participation constitutes each competitor’s full and unconditional agreement to these rules and administrative decisions, which are final and binding in all matters related to the contest. This notice is not an obligation of funds; the final awards are

contingent upon the availability of appropriations.

7. RESOLUTION OF DISPUTES

The U.S. Department of Energy is solely responsible for administrative decisions, which are final and binding in all matters related to the contest.

Neither the U.S. Department of Energy nor the Prize Administrator will arbitrate, intervene, advise on, or resolve any matters between team members or among competitors.

8. PUBLICITY

The L-Prize Concept, Prototype, and Manufacturing and Installation phase winners (collectively, “winners”) will be featured on the DOE and NREL websites.

Except where prohibited, participation in the contest constitutes each winner’s consent to DOE’s and its agents’ use of each winner’s name, likeness, photograph, voice, opinions, and/or hometown and state information for promotional purposes through any form of media worldwide, without further permission, payment, or consideration.

9. LIABILITY

Upon registration, all competitors agree to assume any and all risks of injury or loss in connection with or in any way arising from participation in this contest. Upon registration, except in the case of willful misconduct, all participants agree to and, thereby, do waive and release any and all claims or causes of action against the federal government and its officers, employees, and agents for any and all injury and damage of any nature whatsoever (whether existing or thereafter arising, whether direct, indirect, or consequential, and whether foreseeable or not) arising from their participation in the contest, whether the claim or cause of action arises under contract or tort.

In accordance with the delegation of authority to run this contest delegated to the director of the Building Technologies Office, the director has determined that no liability insurance naming DOE as an insured will be required of competitors to compete in this competition per 15 U.S.C. 3719(i)(2). Competitors should assess the risks associated with their proposed activities and adequately insure themselves against possible losses.

10. RECORDS RETENTION AND FREEDOM OF INFORMATION ACT

All materials submitted to DOE as part of a submission become DOE records and are subject to the Freedom of Information Act (FOIA). The following applies only to portions of the submission not designated as public information in the instructions for submission: If a submission includes trade secrets or information that is commercial or financial, or information that is confidential or privileged, it is furnished to the government in confidence with the understanding that the information shall be used or disclosed only for evaluation of the submission. Such information will be withheld from public disclosure to the extent permitted by law, including the Freedom of Information Act. Without assuming any liability for inadvertent disclosure, DOE will seek to limit disclosure of such information to its employees and to outside reviewers when necessary for review of the submission or as otherwise authorized by law. This restriction does not limit the government’s right to use the information if it is obtained from another source.

Submissions containing confidential, proprietary, or privileged information must be marked as described below.

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Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The United States government is not liable for the disclosure or use of unmarked information and may use or disclose such information for any purpose.

The submission must be marked as follows and identify the specific pages containing trade secrets, confidential, proprietary, or privileged information:

Notice of Restriction on Disclosure and Use of Data:

Pages [list applicable pages] of this document may contain trade secrets, confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for evaluation purposes. [End of Notice]

The header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: “Contains Trade Secrets, Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure.” In addition, each line or paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets.

Competitors will be notified of any Freedom of Information Act requests for their submissions in accordance with 29 C.F.R. § 70.26. Competitors may then have the opportunity to review materials and work with a FOIA representative prior to the release of materials. DOE will make the final determination of whether the materials in question must be released or not.

11. PRIVACY

Competitors that choose to provide HeroX with personal information by registering or completing the submission package through the contest website understand that such information will be transmitted to DOE and may be kept in a system of records. Such information will be used only to respond to competitors in matters regarding their submissions and/or the contest unless they choose to receive updates or notifications about other contests or programs from DOE on an opt-in basis. DOE, NREL, and PNNL do not collect any information for commercial marketing.

12. GENERAL CONDITIONS

DOE reserves the right to cancel, suspend, and/or modify a contest, or any part of it, at any time. If any fraud, technical failures, or any other factor beyond DOE’s reasonable control impairs the integrity or proper functioning of a contest, as determined by DOE in its sole discretion, DOE may cancel the contest.

Although DOE may indicate that it will select up to several winners for each contest, DOE reserves the right to only select competitors that are likely to achieve the goals of the program. If DOE determines that no competitors are likely to achieve the goals of the program, DOE will select no competitors to be winners and will award no prize money.

DOE may conduct a risk review, using Government resources, of the competitor and project personnel for potential risks of foreign interference. The outcomes of the risk review may result in the submission being eliminated from the prize competition. This risk review, and potential elimination, can occur at any time during the prize competition. An elimination based on a risk review is not appealable.

13. PROGRAM POLICY FACTORS

While the scores of the Expert Reviewer Panel will be carefully considered, it is the role of DOE to maximize the

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impact of contest funds. Some factors outside the control of competitors and beyond the Expert Reviewer Panel's scope of review may need to be considered to accomplish this goal. The following is a list of such factors. In addition to the reviewers' scores, the program policy factors below may be considered in no particular order for determining winners and associated prize amounts:

- The level of innovation demonstrated by the proposed luminaire or connected system.
- The feasibility of the proposed luminaire or connected system.
- Geographic diversity and potential economic impact of projects.
- Whether the use of additional DOE funds and provided resources are nonduplicative and compatible with the stated goals of this program and the general DOE mission.
- The degree to which the submission creates opportunities for the improvement of communities that have been historically disadvantaged by addressing diversity, equity, and inclusion, including but not limited to team leadership, partners, affiliations, and locations of competitors and installation sites.
- The degree to which the submission exhibits technological or programmatic diversity when compared to the existing DOE project portfolio and other competitors.
- The level of industry involvement and demonstrated ability to accelerate commercialization and overcome key market barriers.
- The degree to which the submission is likely to lead to increased employment and manufacturing in the United States or provide other economic benefit to U.S. taxpayers.
- The degree to which the activities described in the submission package to this contest have been or will be performed in the United States.
- The degree to which the submission will accelerate transformational technological, financial, or workforce advances in areas that industry by itself is not likely to undertake because of technical or financial uncertainty.
- The degree to which the submission supports complementary DOE-funded efforts or projects, which when taken together, will best achieve the goals and objectives of DOE.
- The degree to which the submission expands DOE funding to new competitors and recipients who have not been supported by DOE in the past.
- The degree to which the submission enables new and expanding market segments.
- Whether the project promotes increased coordination with nongovernmental entities for the demonstration of technologies and research applications to facilitate technology transfer.
- Whether submission content sufficiently confirms the competitor's intent to commercialize early-stage technology and establish a viable U.S.-based business in the near future.

14. NATIONAL ENVIRONMENTAL POLICY ACT COMPLIANCE

DOE administration of the L-Prize is subject to the National Environmental Policy Act (NEPA) (42 U.S.C. 4321, et seq.). NEPA requires federal agencies to integrate environmental values into their decision-making processes by considering the potential environmental impacts of their proposed actions. For additional background on NEPA, please visit <http://nepa.energy.gov>.

While NEPA compliance is a federal agency responsibility and the ultimate decisions remain with the federal agency, all competitors in the L-Prize will be required to assist in the timely and effective completion of the NEPA process in the manner most pertinent to their participation in the prize competition. Competitors may be

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asked to provide DOE with information on fabrication and testing of their device such that DOE can conduct a meaningful evaluation of the potential environmental impacts.

15. RETURN OF FUNDS

As a condition of receiving a prize, competitors agree that if the prize was awarded based on fraudulent or inaccurate information provided by the competitor to DOE, DOE has the right to demand that any prize funds or the value of other noncash prizes be returned to the government.

ALL DECISIONS BY DOE ARE FINAL AND BINDING IN ALL MATTERS RELATED TO THE CONTEST.