U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

RFI: DE-FOA-0001557: Request for Information
High-Efficacy Replacement Lamps for General Lighting Incandescent Lamps

DATE: March 17, 2016
SUBJECT: Request for Information (RFI)

Description

The Emerging Technologies (ET) Program of the United States (U.S.) Department of Energy (DOE) Building Technologies Office (BTO) is seeking information from the public on incandescent lamps in general illumination applications. The ET Program supports applied research and development (R&D) for technologies and systems that contribute to reductions in building energy consumption and helps to enable cost-effective, energy-efficient technologies to be developed and introduced into the marketplace. The following are key areas of interest:

1. Incandescent lamps that currently do not have a suitable replacement lamp meeting or exceeding 45 lumens per watt (lm/W).
2. Gaps in technology that impede (or would likely impede) the design, development and future sale of ≥45 lm/W replacement lighting products.

In particular, BTO is interested in understanding the lamp performance metrics, targets, design criteria, and compatibility issues of suitable replacement lamps, technology advances that could lead to equivalent lighting products meeting or exceeding 45 lm/W, and the potential market impact of new or improved lamps if a suitable product could be developed.

Background

The Energy Independence and Security Act (EISA) of 2007 sets minimum energy efficiency standards for general service lamps, including a 45 lm/W backstop requirement effective beginning January 1, 2020. (42 U.S.C. 6295(i)(6)(A)(v)) Once this legislated backstop provision is triggered, then all general service lamps sold must meet a minimum standard of 45 lm/W. Incandescent lamps are unlikely to meet the 45 lm/W backstop requirement, effectively eliminating general service incandescent lamps from the market. However, there are other lighting technologies that may provide replacement options for these incandescent applications at higher levels of efficacy. In the February 2016 notice of proposed rulemaking (NOPR), DOE proposed a broader definition of general service lamp[1]. In brief, a general service lamp is a lamp that has an ANSI base, operates at any voltage, has an initial lumen output of 310 lumens or

[1] The General Service Lamp definition does not include lamps for several specific lighting applications or certain medium screw base incandescent lamps.

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greater (or 232 lumens or greater for modified spectrum general service incandescent lamps), is not a light fixture, is not an LED downlight retrofit kit, and is used in general lighting applications.

DOE has identified several incandescent lamp types that do not currently have suitable replacements that meet the Statute's backstop performance level. To be considered a suitable replacement, the proposed technology must maintain the base, shape, and lumen output of the incandescent/halogen lamp it was designed to replace. Solely replicating existing lighting form factors is usually not sufficient and leads to a number of compatibility issues. Incompatibility can derive from differences in physical appearance, dimensions, operation and light distribution. This can result in lighting products that do not quite fit into existing light fixtures or light distribution patterns that do not replicate the product they are replacing. Incompatibility can also result from differences in performance characteristics such as light output, color temperature and color quality. Compatibility with dimmer switches or lighting controls is often another problem, which can lead to flickering, audible buzzing, non-linear dimming, and/or inconsistent dimming.

Minimizing or eliminating incompatibility is important to ensure consumer acceptance and, as a result, increase market adoption of higher-efficacy lamps and realize associated energy savings. Table 1, below, lists metrics and design criteria relevant for measuring or evaluating the performance, compatibility, and suitability of a replacement lamp.

Table 1: Lamp Performance Metrics and Design Criteria

Lumen maintenance (L_{70}) (hrs)
Efficacy (lm/W)
Color rendering index (CRI) & R9 score
Correlated color temperature (CCT in Kelvin)
Lifetime (hrs)
First cost ($/klm)
Power factor (min)
Beam angle (degrees)
Center beam candle power (CBCP in candelas)
Dimmable (y/n, if yes, dimmable down to x%)
Light output (lm)
Luminous intensity distribution
Lamp shape dimensions
Flicker

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Color stability (Δu'v')
Energy Star V2.0 compliance (y/n)

Table 2, below, lists the incandescent/halogen lamp types that were identified as not having suitable replacements, particularly in higher lumen ranges, and therefore present areas of interest where additional R&D may be necessary to develop cost-effective and higher efficacy replacement lamp solutions.

Table 2: Incandescent Lamps lacking Suitable Replacement Lamps exceeding 45 lm/W

#	Lamp Base	Shape	Lamps Lacking Suitable Replacements
Category A – Small Directional Lamps			
A1	MR16	GU5.3	≥ 700 lm
A2	MR16	GU10	≥ 800 lm
A3	MR16	GX5.3	≥ 500 lm
Category B – Candelabra Decorative Lamps			
B1	Candelabra (E12) base	A15	≥ 310 lm
B2	Candelabra (E12) base	B10	≥ 310 lm
B3	Candelabra (E12) base	B11	≥ 310 lm
B4	Candelabra (E12) base	B13	≥ 310 lm
B5	Candelabra (E12) base	CA10	≥ 500 lm
B6	Candelabra (E12) base	C7	≥ 310 lm
B7	Candelabra (E12) base	C11	≥ 500 lm
Category C – Omnidirectional Medium Screw Base Lamps			
C1	Medium screw base (E26) non-reflector	B10	≥ 310 lm
C2	Medium screw base (E26) non-reflector	B11	≥ 400 lm
C3	Medium screw base (E26) non-reflector	CA10	≥ 310 lm
Category D – Pin-Base Tubular Lamps			
D1	Pin-base halogen	Tubular	≥ 310 lm (LED lamps < 500 lm exist but size is significantly different)

Purpose

The purpose of this RFI is to solicit feedback from industry, academia, research laboratories, government agencies, and other stakeholders on questions related to general service incandescent lamps that do not have suitable lamp replacements meeting or exceeding the EISA 2007 45 lm/W backstop requirement, as well as the needed attributes and performance metrics of higher efficacy replacement lamps for these general service incandescent lamps. BTO is specifically interested in information and data to help identify R&D opportunities that could

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enable and accelerate the development of compliant lighting solutions. This is solely a request for information and not a Funding Opportunity Announcement (FOA). EERE is not accepting applications.

Disclaimer and Important Notes

This RFI is not a Funding Opportunity Announcement (FOA); therefore, EERE is not accepting applications at this time. EERE may issue a FOA in the future based on or related to the content and responses to this RFI; however, EERE may also elect not to issue a FOA. There is no guarantee that a FOA will be issued as a result of this RFI. Responding to this RFI does not provide any advantage or disadvantage to potential applicants if EERE chooses to issue a FOA regarding the subject matter. Final details, including the anticipated award size, quantity, and timing of EERE funded awards, will be subject to Congressional appropriations and direction.

Any information obtained as a result of this RFI is intended to be used by the Government on a non-attribution basis for planning and strategy development; this RFI does not constitute a formal solicitation for proposals or abstracts. Your response to this notice will be treated as information only. EERE will review and consider all responses in its formulation of program strategies for the identified materials of interest that are the subject of this request. EERE will not provide reimbursement for costs incurred in responding to this RFI. Respondents are advised that EERE is under no obligation to acknowledge receipt of the information received or provide feedback to respondents with respect to any information submitted under this RFI. Responses to this RFI do not bind EERE to any further actions related to this topic.

Proprietary Information

Because information received in response to this RFI may be used to structure future programs and FOAs and/or otherwise be made available to the public, **respondents are strongly advised to NOT include any information in their responses that might be considered business sensitive, proprietary, or otherwise confidential.** If, however, a respondent chooses to submit business sensitive, proprietary, or otherwise confidential information, it must be clearly and conspicuously marked as such in the response.

Responses containing confidential, proprietary, or privileged information must be conspicuously marked as described below. 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 U.S. Federal Government is not liable for the disclosure or use of unmarked information, and may use or disclose such information for any purpose.

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If your response contains confidential, proprietary, or privileged information, you must include a cover sheet marked as follows identifying the specific pages containing confidential, proprietary, or privileged information:

> **Notice of Restriction on Disclosure and Use of Data:**
> Pages [List Applicable Pages] of this response may contain confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for the purposes described in this RFI DE-FOA-0001557. The Government may use or disclose any information that is not appropriately marked or otherwise restricted, regardless of source.

In addition, (1) the header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: "Contains Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure" and (2) every line and paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets or highlighting.

Evaluation and Administration by Federal and Non-Federal Personnel

Federal employees are subject to the non-disclosure requirements of a criminal statute, the Trade Secrets Act, 18 USC 1905. The Government may seek the advice of qualified non-Federal personnel. The Government may also use non-Federal personnel to conduct routine, nondiscretionary administrative activities. The respondents, by submitting their response, consent to EERE providing their response to non-Federal parties. Non-Federal parties given access to responses must be subject to an appropriate obligation of confidentiality prior to being given the access. Submissions may be reviewed by support contractors and private consultants.

Request for Information Questions

Information is sought in response to the following questions for each of the four (4) lamp categories (A-D) listed in Table 2 in the Background section. These questions address the current state-of-the-art of lamp technologies, as well as research frontiers and the potential market impact of improved higher efficacy general service replacement lamps.

1. What higher-efficacy (≥ 45 lm/W) technologies represent the current state-of-the-art, commercially available replacement lamps in this category? For each of these higher-efficacy technologies, please answer the following questions for each lamp base and shape in this category:
   - What is the highest lumen output of these higher-efficacy lamps?

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- What is the efficacy or range of efficacies (lm/W) for the highest lumen output lamps?
- What percentage of sales of traditional incandescent/halogen lamps comprise lamps exceeding this maximum lumen output of higher-efficacy lamps?
- Are the higher-efficacy lamps suitable and equivalent replacements for the incandescent lamps? Are there compatibility issues? Provide details. Are there any other notable limitations or shortcomings? Provide details.

2. Table 1 in the background section above includes a list of performance metrics (i.e., ways of measuring or evaluating the performance of a lamp technology). What additional metrics or design criteria, if any, are missing from this list that are important in evaluating the performance of the products of the four categories?
    a. What are the appropriate performance metrics for current state-of-the-art, commercially available higher-efficacy lamps under this category, considering the most relevant target market (consumer or commercial)?
    b. What are "good"[2] and "excellent" [3] quantitative values (i.e., targets) for those metrics for comparing different lamp products under this category? Please provide separate responses for each lamp base and shape, if targets are materially different.
    c. How would you rate the importance of each metric or design criterion (i.e., 1st tier / most important, 2nd tier / somewhat important, 3rd tier / least important) for the lamps under this category for the most relevant target market (consumer or commercial)?
    d. Would the "excellent" targets greatly accelerate or unlock market adoption of the higher-efficacy replacement lamps under this category? What other market barriers are relevant?

3. What are market-acceptable lamp costs for higher-efficacy technologies in this category? Please provide separate responses specific to residential/consumer and commercial markets.

4. What are the R&D challenges that must be resolved before suitable high-efficacy, higher lumen replacement lamps under this category could be commercially available? What R&D opportunities remain for improving the performance or reducing the cost of existing high-efficacy lamp technologies? To what extent do you expect lamp technologies to improve in the next 2-4 years?

[2] "Good" – meets or exceeds minimum performance requirements for a given lighting application.
[3] "Excellent" – as close to ideal performance and incandescent lamp quality equivalency as possible. Deemed an ideal suitable replacement for an incandescent lamp.

5. Are there intermediate innovations or key enabling technologies that require R&D that would enable the development of suitable high-efficacy replacement lamps under this category in the next 2-4 years? What are these enabling technologies or innovations?

6. What five (5) lamp types (base and shape), in rank order, would represent the greatest market potential and impact if a high-efficacy, higher lumen replacement lamp could be developed? What additional lamp types that do not have suitable high-efficacy replacement lamp alternatives, if any, are missing from this list?

Request for Information Response Guidelines

Responses to this RFI must be submitted electronically to **GSLRFI@netl.doe.gov** no later than 5:00pm (ET) on April 4, 2016. Responses must be provided as attachments to an email. It is recommended that attachments with file sizes exceeding 25MB be compressed (i.e., zipped) to ensure message delivery. Responses must be provided as a Microsoft Word (.docx) attachment to the email, and no more than 10 pages in length, 12 point font, 1 inch margins. Only electronic responses will be accepted.

Please identify your answers by responding to a specific question or topic if applicable. Respondents may answer as many or as few questions as they wish.

EERE will not respond to individual submissions or publish publicly a compendium of responses. A response to this RFI will not be viewed as a binding commitment to develop or pursue the project or ideas discussed.

Respondents are requested to provide the following information at the start of their response to this RFI:

- Company / institution name;
- Company / institution contact;
- Contact's address, phone number, and e-mail address.

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