STATE OF CALIFORNIA

GRANT REQUEST FORM (GRF)

CEC-270 (Revised 02/13) CALIFORNIA ENERGY COMMISSION

New Agreement EPC-14-014 (To be completed by CGL Office)

Division	Agreement Manager:	MS-	Phone
ERDD	Felix Villanueva	51	916-327-2206

Recipient's Legal Name	Federal ID Number
CREE, Inc.	56-1572719

Title of Project
"Novel High-Efficacy, Low-Cost LED Luminaires"

Term and Amount	Start Date	End Date	Amount
	6/30/2015	6/30/2017	$ 2,774,920

Business Meeting Information

☐ ARFVTP agreements under $75K delegated to Executive Director.

Proposed Business Meeting Date	2/25/2015	☐ Consent	☒ Discussion
Business Meeting Presenter	Felix Villanueva	Time Needed:	5 minutes

Please select one list serve. Select

Agenda Item Subject and Description

Possible approval of this agreement with CREE, Inc. to develop high-efficacy, low-cost LED luminaires based on a novel lightguide optics architecture in the amount of $2,774,920.00. The length of this agreement is 24 months.

California Environmental Quality Act (CEQA) Compliance

1. Is Agreement considered a "Project" under CEQA?
   ☐ Yes (skip to question 2) ☒ No (complete the following (PRC 21065 and 14 CCR 15378)):
   Explain why Agreement is not considered a "Project":
   Agreement will not cause direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment because The activities funded by the agreement will not cause a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment because of a portion of the activities will consist of design, simulation, and testing. Another portion will consist of laboratory work using small quantities of chemicals which are either not hazardous, or if hazardous are collected and disposed of properly in compliance with local and state regulations.
2. If Agreement is considered a "Project" under CEQA:
   ☐ a) Agreement **IS** exempt. (Attach draft NOE)
   ☐ Statutory Exemption. List PRC and/or CCR section number: _____
   ☐ Categorical Exemption. List CCR section number: _____
   ☐ Common Sense Exemption. 14 CCR 15061 (b) (3)
   Explain reason why Agreement is exempt under the above section:
   _____
   ☐ b) Agreement **IS NOT** exempt. (Consult with the legal office to determine next steps.)
   Check all that apply
   ☐ Initial Study ☐ Environmental Impact Report
   ☐ Negative Declaration ☐ Statement of Overriding Considerations
   ☐ Mitigated Negative Declaration

List all subcontractors (major and minor) and equipment vendors: (attach additional sheets as necessary)

Legal Company Name:	Budget
	$
	$
	$
	$
	$
	$
	$
	$
	$

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List all key partners: (attach additional sheets as necessary)
Legal Company Name:

Budget Information

Funding Source	Funding Year of Appropriation	Budget List No.	Amount
EPIC	13-14	301.001A	$2,774,920
			$
			$
			$
			$
			$
R&D Program Area: EERO: Buildings		TOTAL:	$2,774,920
Explanation for "Other" selection			
Reimbursement Contract #:		Federal Agreement #:	

Recipient's Administrator/ Officer				**Recipient's Project Manager**			
Name:	Sharon Degnan			Name:	Paul Fini		
Address:	4600 SILICON DR			Address:	340 STORKE RD		
City, State, Zip:	DURHAM, NC 27703-8475			City, State, Zip:	GOLETA, CA 93117-2993		
Phone:	919-407-5554 /	Fax:	- -	Phone:	805-690-3032 /	Fax:	- -
E-Mail:	sharon_degnan@cree.com			E-Mail:	paul_fini@cree.com		

Selection Process Used

☒ Competitive Solicitation Solicitation #: PON-13-301
☐ First Come First Served Solicitation

The following items should be attached to this GRF

1. Exhibit A, Scope of Work		☒ Attached
2. Exhibit B, Budget Detail		☒ Attached
3. CEC 105, Questionnaire for Identifying Conflicts		☒ Attached
4. Recipient Resolution	☐ N/A	☐ Attached
5. CEQA Documentation	☒ N/A	☐ Attached

Agreement Manager	Date	Office Manager	Date	Deputy Director	Date

Exhibit A
Scope of Work

A. Task List

Task #	CPR[1]	Task Name
1		General Project Tasks
2		LED Component Development
3		Lightguide Light Coupling
4		Lightguide Light Extraction
5		Electrical Circuitry, Drivers, Controls
6	X	Luminaire Integration, including Mechanical/Structural Elements
7		Evaluation of Project Benefits
8		Technology/Knowledge Transfer Activities
9		Production Readiness Plan

B. Acronym/Term List

Acronym/Term	Meaning
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CCT	Correlated Color Temperature (K)
CPR	Critical Project Review
CRI	Color Rendering Index
LED	Light Emitting Diode
Lm/W	Lumens per Watt
klm	Kilo-lumens
SBTC	Santa Barbara Technology Center
SSL	Solid-State Lighting
TAC	Technical Advisory Committee

I. PURPOSE OF AGREEMENT, PROBLEM/SOLUTION STATEMENT, AND GOALS AND OBJECTIVES

A. Purpose of Agreement

The purpose of this Agreement is to fund advanced research and development of novel high-efficacy light emitting diode (LED) luminaires at Cree Santa Barbara Technology Center (SBTC) in Goleta, CA. Specifically, Recipient will pursue development in the areas of: LED optics and light downconversion; LED color quality; lightguide optics; mechanical/structural subsystems; and power & control electronics.

B. Problem/Solution Statement

Problem

Solid-state lighting (SSL) has emerged as the most efficient lighting technology, with luminous efficacy (light output per unit electrical power input) values 5-10 times that of traditional lighting

[1] Please see subtask 1.3 in Part III of the Scope of Work (General Project Tasks) for a description of Critical Project Review (CPR) Meetings.

technology. SSL has the potential to greatly reduce energy use for lighting, which typically makes up a fifth of building electricity loads. However, SSL's average normalized cost per unit of light delivered ($/klm) has not yet fallen to levels comparable to current incandescent and fluorescent technologies. Left to market forces alone, the affordability of SSL is expected to reach that of fluorescent, incandescent or high intensity discharge lighting in 6-7 years – leaving ~150 TWhrs of potential nationwide energy savings unharvested.[2] Furthermore, without strong investment in the continuous advancement of domestic SSL technology, the nascent U.S. SSL industry may be exploited by potentially low-quality, low-cost foreign companies. Today SSL already offers cost of ownership advantages (*e.g.* lower electricity bills, long lifetime, no maintenance) in numerous applications, but the initial purchase price remains a barrier to widespread adoption.

SSL luminaires (whether conventional or lightguide-based) typically have much lower efficacy (100-110 lumens per watt (lm/W)) and higher normalized cost ($30-50/klm) than Recipient proposes to develop as part of this project. Next-generation lightguide-based optics offer a means of radically reducing both the purchase price and cost of ownership of wide-area SSL luminaires. The technology advancements, the Recipient proposes will provide a significant stepping stone towards reducing SSL luminaire normalized purchase price to achieve parity with fluorescent troffer fixtures (~$15-20/klm), while offering superior features such as excellent color rendering and smooth dimming.

Solution

Over the course of the proposed program the Recipient will develop novel technologies to break through present barriers in distributing light efficiently, uniformly, and economically from LEDs (which are quasi-point sources) over large luminaire surface areas for optimal distribution to the user. This requires holistic design of: the LED semiconductor chips and components themselves; the manner in which their light is coupled into lightguides; and the means by which this guided light is emitted to illuminate the surrounding room. Holistic design will entail new architectures which may radically depart from conventional approaches. The resulting lightguide luminaires will consist of low-profile, lightweight designs in which there are few, if any, additional structural and thermal management components. Low material and assembly costs will enable a new class of SSL luminaires with very low normalized end-user purchase price, finally reaching parity with or even surpassing in select cases conventional fluorescent fixtures. The accelerated (by 3-5 years) adoption of cost-effective SSL luminaires by California ratepayers will help California reach its zero net energy goals and stay at the forefront of energy efficiency nationwide.

C. Goals and Objectives of the Agreement

Agreement Goals

The goal of this Agreement is to develop efficient, cost-effective SSL lightguide luminaires with an efficacy of >150 lm/W at color temperatures of 3000-3500K and high color quality (Color Rendering Index >90, or equivalent). The target normalized price is $20/klm or less. The target luminaire efficacy is 150 lm/W compared to conventional T8 linear fluorescent fixtures (75-80 lm/W), roughly half of the energy (in kilowatt-hours) would

[2] "Energy Savings Forecast of Solid-State Lighting in General Illumination Applications", prepared by Navigant Consulting for the U.S. Dept. of Energy, August 2014.
http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/energysavingsforecast14.pdf

be used for LED luminaire assuming it runs about the same amount of time as its fluorescent counterpart.

Ratepayer Benefits:[3] The proposed lightguide architecture will set the stage for accelerated adoption of SSL in a key class luminaires, thereby obsolescing inefficient and environmentally unfriendly conventional lighting fixtures. It will remove remaining barriers to widespread California ratepayer adoption of SSL luminaires via a combination of low cost, high efficiency, and high color quality. The proposed innovations will offer both residential and commercial ratepayers more rapid (or even eliminated in case of cost parity) payback periods relative to conventional luminaires. Moreover, commercial and residential ratepayers alike will benefit from long lifetime (10-20 years) and decreased cost of ownership (lower energy bills and little to no maintenance).

High-efficacy LED lightguide luminaires will directly contribute to a revolution in total building energy efficiency by not only consuming lower operating power, but also via the correspondingly reduced waste heat loads building HVAC systems must currently compensate for. Both factors will contribute to buildings which place less variable demand on the grid, resulting in fewer brownouts and outages during periods of peak demand. A more reliable energy supply for California ratepayers will result, in particular when upcoming residential and commercial Zero Net Energy practices are implemented.

Technological Advancement and Breakthroughs:[4] This Agreement will lead to technological advancement and breakthroughs to overcome barriers to achieving the State of California's energy goals by impacting a key energy segment in both residential and commercial markets: lighting.

Recipient plans to overcome the performance (efficacy: lumens per watt) and cost ($/kilolumen) shortcomings of present SSL fixtures. The proposed next-generation lightguide-based optics offer a means of radically reducing both purchase price and cost of ownership of these luminaires. This will be made possible via simultaneous gains in system optical efficiency and reductions in bill of materials and assembly costs via design simplification. The technology advancements Recipient proposes will provide a stepping stone towards reducing SSL luminaire normalized purchase prices from typical current levels of >$30/klm to parity with fluorescent troffer fixtures (~$15-20/klm), while offering superior features such as excellent color rendering and smooth dimming. Meanwhile, a system efficacy of >150 lm/W will provide owners with half of the recurring energy costs of fluorescent fixtures (70-80 lm/W).

Widespread adoption of next-generation SSL luminaires will directly contribute to the feasibility of achieving California's 2020 Residential Zero Net Energy (ZNE) goals. The success of ZNE will be contingent upon not just improvements in on-site building energy supply, but overall load reduction. A recent report[5] predicts that **SSL will have the largest impact on energy costs of**

[3] California Public Resources Code, Section 25711.5(a) requires projects funded by the Electric Program Investment Charge (EPIC) to result in ratepayer benefits. The California Public Utilities Commission, which established the EPIC in 2011, defines ratepayer benefits as greater reliability, lower costs, and increased safety (See CPUC "Phase 2" Decision 12-05-037 at page 19, May 24, 2012, http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/167664.PDF).

[4] California Public Resources Code, Section 25711.5(a) also requires EPIC-funded projects to lead to technological advancement and breakthroughs to overcome barriers that prevent the achievement of the state's statutory and energy goals.

[5] ARUP NA, "The Technical Feasibility of Zero Net Energy Buildings in California", Table 16, Dec. 2012.

any building subsystem, with a calculated annual reduction of $4.70/ft^2 in 'time-dependent value' (an energy cost metric which includes variable retail rates, carbon allowances, and transmission capacity) for new construction, compared to just $2.57/ft^2 from plug load reductions, for example.

Agreement Objectives

The objectives of this Agreement are focused on developing several technologies that will all contribute to industry-leading LED luminaires. Specifically, Recipient will advance these technological subsystems as follows:

- **High-efficacy LED components** with emission vs. angle designed for efficient light coupling into lightguides, as well as optimized spectral characteristics. High efficacy (>185 lm/W) will be a central focus.
  - Benefit: Eliminate the complexity and materials & assembly costs of secondary optics systems, and lower the number of components required in the system.
- **Low-loss lightguides** with light coupling and extraction optics that efficiently convey light from LEDs (point sources) to broad luminaire surfaces (area sources).
  - Benefit: Lightguides function to steer light into precise, efficient illumination patterns and can function as safety enclosures, reducing cost and saving energy.
- **Electrical circuitry and drivers** that have low cost and high efficiency (>95%), and also offer compatibility with smart controls (*e.g.* over wireless networks).
  - Benefit**:** Integrate novel energy-efficient power conversion circuit topologies into lighting products and add value through higher-level control functionality to general lighting products.
- **Luminaire mechanical integration** that includes minimized or eliminated thermal and mechanical elements, and with designs that entail low assembly costs.
  - Benefit: Low-cost, unobtrusive luminaire architectures will accelerate adoption by removing procurement barriers and facilitate simpler, less invasive installation options.

II. TASK 1. GENERAL PROJECT TASKS

PRODUCTS

Subtask 1.1 Products

The goal of this subtask is to establish the requirements for submitting project products (e.g., reports, summaries, plans, and presentation materials). Unless otherwise specified by the Commission Agreement Manager (CAM), the Recipient must deliver products as required below by the dates listed in the **Project Schedule (Part V).** Products that require a draft version are indicated by marking **"(draft and final)"** after the product name in the "Products" section of the task/subtask. If "(draft and final)" does not appear after the product name, only a final version of the product is required. With respect to due dates within this Scope of Work, **"days"** means working days.

The Recipient shall:

For products that require a draft version

- Submit all draft products to the CAM for review and comment in accordance with the Project Schedule (Part V). The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt, unless otherwise specified in the task/subtask for which the product is required.
- Submit the final product to the CAM once agreement has been reached on the draft. The CAM will provide written approval of the final product within 15 days of receipt, unless otherwise specified in the task/subtask for which the product is required.
- If the CAM determines that the final product does not sufficiently incorporate his/her comments, submit the revised product to the CAM within 10 days of notice by the CAM, unless the CAM specifies a longer time period.

For products that require a final version only

- Submit the product to the CAM for approval.
- If the CAM determines that the product requires revision, submit the revised product to the CAM within 10 days of notice by the CAM, unless the CAM specifies a longer time period.

For all products

- Submit all data and documents required as products in accordance with the following Instructions for Submitting Electronic Files and Developing Software:

    - **Electronic File Format**
      Submit all data and documents required as products under this Agreement in an electronic file format that is fully editable and compatible with the Energy Commission's software and Microsoft (MS)-operating computing platforms, or with any other format approved by the CAM. Deliver an electronic copy of the full text of any Agreement data and documents in a format specified by the CAM, such as memory stick or CD-ROM.

      The following describes the accepted formats for electronic data and documents provided to the Energy Commission as products under this Agreement, and establishes the software versions that will be required to review and approve all software products:
        - Data sets will be in MS Access or MS Excel file format (version 2007 or later), or any other format approved by the CAM.
        - Text documents will be in MS Word file format, version 2007 or later.
        - Documents intended for public distribution will be in PDF file format. The Recipient must also provide the native Microsoft file format.
        - Project management documents will be in Microsoft Project file format, version 2007 or later.

    - ***Software Application Development***
      Use the following standard Application Architecture components in compatible versions for any software application development required by this Agreement (e.g., databases, models, modeling tools), unless the CAM approves other software applications such as open source programs:
        - Microsoft ASP.NET framework (version 3.5 and up). Recommend 4.0.
        - Microsoft Internet Information Services (IIS), (version 6 and up)

Recommend 7.5.
- Visual Studio.NET (version 2008 and up). Recommend 2010.
- C# Programming Language with Presentation (UI), Business Object and Data Layers.
- SQL (Structured Query Language).
- Microsoft SQL Server 2008, Stored Procedures. Recommend 2008 R2.
- Microsoft SQL Reporting Services. Recommend 2008 R2.
- XML (external interfaces).

Any exceptions to the Electronic File Format requirements above must be approved in writing by the CAM. The CAM will consult with the Energy Commission's Information Technology Services Branch to determine whether the exceptions are allowable.

MEETINGS

Subtask 1.2 Kick-off Meeting
The goal of this subtask is to establish the lines of communication and procedures for implementing this Agreement.

The Recipient shall:
- Attend a "Kick-off" meeting with the CAM, the Commission Agreement Officer (CAO), and any other Energy Commission staff relevant to the Agreement. The Recipient will bring its Project Manager and any other individuals designated by the CAM to this meeting. The administrative and technical aspects of the Agreement will be discussed at the meeting. Prior to the meeting, the CAM will provide an agenda to all potential meeting participants. The meeting may take place in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

  The administrative portion of the meeting will include discussion of the following:
  - Terms and conditions of the Agreement;
  - Administrative products (subtask 1.1);
  - CPR meetings (subtask 1.3);
  - Match fund documentation (subtask 1.7);
  - Permit documentation (subtask 1.8);
  - Subcontracts (subtask 1.9); and
  - Any other relevant topics.

  The technical portion of the meeting will include discussion of the following:
  - The CAM's expectations for accomplishing tasks described in the Scope of Work;
  - An updated Project Schedule;
  - Technical products (subtask 1.1);
  - Progress reports and invoices (subtask 1.5);
  - Final Report (subtask 1.6);
  - Technical Advisory Committee meetings (subtasks 1.10 and 1.11); and
  - Any other relevant topics.

- Provide an *Updated Project Schedule, List of Match Funds,* and *List of Permits*, as needed to reflect any changes in the documents.

The CAM shall:

- Designate the date and location of the meeting.
- Send the Recipient a *Kick-off Meeting Agenda*.

Recipient Products:

- Updated Project Schedule *(if applicable)*
- Updated List of Match Funds *(if applicable)*
- Updated List of Permits *(if applicable)*

CAM Product:

- Kick-off Meeting Agenda

Subtask 1.3 Critical Project Review (CPR) Meetings

The goal of this subtask is to determine if the project should continue to receive Energy Commission funding, and if so whether any modifications must be made to the tasks, products, schedule, or budget. CPR meetings provide the opportunity for frank discussions between the Energy Commission and the Recipient. As determined by the CAM, discussions may include project status, challenges, successes, advisory group findings and recommendations, final report preparation, and progress on technical transfer and production readiness activities (if applicable). Participants will include the CAM and the Recipient, and may include the CAO and any other individuals selected by the CAM to provide support to the Energy Commission.

CPR meetings generally take place at key, predetermined points in the Agreement, as determined by the CAM and as shown in the Task List on page 1 of this Exhibit. However, the CAM may schedule additional CPR meetings as necessary. The budget will be reallocated to cover the additional costs borne by the Recipient, but the overall Agreement amount will not increase. CPR meetings generally take place at the Energy Commission, but they may take place at another location, or may be conducted via electronic conferencing (e.g., WebEx) as determined by the CAM.

The Recipient shall:

- Prepare a *CPR Report* for each CPR meeting that: (1) discusses the progress of the Agreement toward achieving its goals and objectives; and (2) includes recommendations and conclusions regarding continued work on the project.
- Submit the CPR Report along with any other *Task Products* that correspond to the technical task for which the CPR meeting is required (i.e., if a CPR meeting is required for Task 2, submit the Task 2 products along with the CPR Report).
- Attend the CPR meeting.
- Present the CPR Report and any other required information at each CPR meeting.

The CAM shall:

- Determine the location, date, and time of each CPR meeting with the Recipient's input.
- Send the Recipient a *CPR Agenda* and a *List of Expected CPR Participants* in advance of the CPR meeting. If applicable, the agenda will include a discussion of match funding and permits.

- Conduct and make a record of each CPR meeting. Provide the Recipient with a *Schedule for Providing a Progress Determination* on continuation of the project.
- Determine whether to continue the project, and if so whether modifications are needed to the tasks, schedule, products, or budget for the remainder of the Agreement. If the CAM concludes that satisfactory progress is not being made, this conclusion will be referred to the Deputy Director of the Energy Research and Development Division.
- Provide the Recipient with a *Progress Determination* on continuation of the project, in accordance with the schedule. The Progress Determination may include a requirement that the Recipient revise one or more products.

Recipient Products:

- CPR Report(s)
- Task Products (draft and/or final as specified in the task)

CAM Products:

- CPR Agenda
- List of Expected CPR Participants
- Schedule for Providing a Progress Determination
- Progress Determination

Subtask 1.4 Final Meeting

The goal of this subtask is to complete the closeout of this Agreement.

The Recipient shall:

- Meet with Energy Commission staff to present project findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement. This meeting will be attended by the Recipient and CAM, at a minimum. The meeting may occur in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

  The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be divided into two separate meetings at the CAM's discretion.
  - The technical portion of the meeting will involve the presentation of findings, conclusions, and recommended next steps (if any) for the Agreement. The CAM will determine the appropriate meeting participants.
  - The administrative portion of the meeting will involve a discussion with the CAM and the CAO of the following Agreement closeout items:
    - Disposition of any state-owned equipment.
    - Need to file a Uniform Commercial Code Financing Statement (Form UCC-1) regarding the Energy Commission's interest in patented technology.
    - The Energy Commission's request for specific "generated" data (not already provided in Agreement products).
    - Need to document the Recipient's disclosure of "subject inventions" developed under the Agreement.
    - "Surviving" Agreement provisions such as repayment provisions and confidential products.
    - Final invoicing and release of retention.

- Prepare a *Final Meeting Agreement Summary* that documents any agreement made between the Recipient and Commission staff during the meeting.
- Prepare a *Schedule for Completing Agreement Closeout Activities*.
- Provide *All Draft and Final Written Products* on a CD-ROM or USB memory stick, organized by the tasks in the Agreement.

Products:

- Final Meeting Agreement Summary *(if applicable)*
- Schedule for Completing Agreement Closeout Activities
- All Draft and Final Written Products

REPORTS AND INVOICES

Subtask 1.5 Progress Reports and Invoices

The goals of this subtask are to: (1) periodically verify that satisfactory and continued progress is made towards achieving the project objectives of this Agreement; and (2) ensure that invoices contain all required information and are submitted in the appropriate format.

The Recipient shall:

- Submit a monthly *Progress Report* to the CAM. Each progress report must:
    - Summarize all Agreement activities conducted by the Recipient for the preceding month, including an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. See the Progress Report Format Attachment for the recommended specifications.
    - Provide a synopsis of the project progress, including accomplishments, problems, milestones, products, schedule, fiscal status, and any evidence of progress such as photographs.
- Submit a monthly or quarterly *Invoice* that follows the instructions in the "Payment of Funds" section of the terms and conditions. In addition, each invoice must document and verify:
    - Energy Commission funds received by California-based entities;
    - Energy Commission funds spent in California *(if applicable)*; and
    - Match fund expenditures.

Products:

- Progress Reports
- Invoices

Subtask 1.6 Final Report

The goal of this subtask is to prepare a comprehensive Final Report that describes the original purpose, approach, results, and conclusions of the work performed under this Agreement. The CAM will review and approve the Final Report, which will be due at least **two months** before the Agreement end date. When creating the Final Report Outline and the Final Report, the Recipient must use a Style Manual provided by the CAM.

Subtask 1.6.1 Final Report Outline

The Recipient shall:

- Prepare a *Final Report Outline* in accordance with the *Style Manual* provided by the CAM.
- Submit a draft of the outline to the CAM for review and comment.
- Once agreement has been reached on the draft, submit the final outline to the CAM. The CAM will provide written approval of the final outline within 10 days of receipt.

Recipient Products:

- Final Report Outline (draft and final)

CAM Product:

- Style Manual

Subtask 1.6.2 Final Report

The Recipient shall:

- Prepare a *Final Report* for this Agreement in accordance with the approved Final Report Outline and the Style Manual provided by the CAM.
- Submit a draft of the report to the CAM for review and comment. Once agreement on the draft report has been reached, the CAM will forward the electronic version for Energy Commission internal approval. Once the CAM receives approval, he/she will provide written approval to the Recipient.
- Submit one bound copy of the Final Report to the CAM.

Products:

- Final Report (draft and final)

MATCH FUNDS, PERMITS, AND SUBCONTRACTS

Subtask 1.7 Match Funds

The goal of this subtask is to ensure that the Recipient obtains any match funds planned for this Agreement and applies them to the Agreement during the Agreement term.

While the costs to obtain and document match funds are not reimbursable under this Agreement, the Recipient may spend match funds for this task. The Recipient may only spend match funds during the Agreement term, either concurrently or prior to the use of Energy Commission funds. Match funds must be identified in writing, and the Recipient must obtain any associated commitments before incurring any costs for which the Recipient will request reimbursement.

The Recipient shall:

- Prepare a *Match Funds Status Letter* that documents the match funds committed to this Agreement. If no match funds were part of the proposal that led to the Energy Commission awarding this Agreement and none have been identified at the time this Agreement starts, then state this in the letter.

If match funds were a part of the proposal that led to the Energy Commission awarding this Agreement, then provide in the letter:

- A list of the match funds that identifies:
  - The amount of cash match funds, their source(s) (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied.
  - The amount of each in-kind contribution, a description of the contribution type (e.g., property, services), the documented market or book value, the source (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Recipient must identify its owner and provide a contact name, address, telephone number, and the address where the property is located.
- A copy of a letter of commitment from an authorized representative of each source of match funding that the funds or contributions have been secured.

- At the Kick-off meeting, discuss match funds and the impact on the project if they are significantly reduced or not obtained as committed. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide a *Supplemental Match Funds Notification Letter* to the CAM of receipt of additional match funds.
- Provide a *Match Funds Reduction Notification Letter* to the CAM if existing match funds are reduced during the course of the Agreement. Reduction of match funds may trigger a CPR meeting.

Products:

- Match Funds Status Letter
- Supplemental Match Funds Notification Letter *(if applicable)*
- Match Funds Reduction Notification Letter *(if applicable)*

Subtask 1.8 Permits

The goal of this subtask is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track. Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement, with the exception of costs incurred by University of California recipients. Permits must be identified and obtained before the Recipient may incur any costs related to the use of the permit(s) for which the Recipient will request reimbursement.

The Recipient shall:

- Prepare a *Permit Status Letter* that documents the permits required to conduct this Agreement. If no permits are required at the start of this Agreement, then state this in the letter. If permits will be required during the course of the Agreement, provide in the letter:
  - A list of the permits that identifies: (1) the type of permit; and (2) the name, address, and telephone number of the permitting jurisdictions or lead agencies.
  - The schedule the Recipient will follow in applying for and obtaining the permits.

  The list of permits and the schedule for obtaining them will be discussed at the Kick-off meeting (subtask 1.2), and a timetable for submitting the updated list, schedule, and copies of the permits will be developed. The impact on the project if the permits are not

obtained in a timely fashion or are denied will also be discussed. If applicable, permits will be included as a line item in progress reports and will be a topic at CPR meetings.

- If during the course of the Agreement additional permits become necessary, then provide the CAM with an *Updated List of Permits* (including the appropriate information on each permit) and an *Updated Schedule for Acquiring Permits*.
- Send the CAM a *Copy of Each Approved Permit*.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the CAM within 5 days. Either of these events may trigger a CPR meeting.

Products:

- Permit Status Letter
- Updated List of Permits *(if applicable)*
- Updated Schedule for Acquiring Permits *(if applicable)*
- Copy of each Approved Permit *(if applicable)*

Subtask 1.9 Subcontracts

The goals of this subtask are to: (1) procure subcontracts required to carry out the tasks under this Agreement; and (2) ensure that the subcontracts are consistent with the terms and conditions of this Agreement.

The Recipient shall:

- Manage and coordinate subcontractor activities in accordance with the requirements of this Agreement.
- Incorporate this Agreement by reference into each subcontract.
- Include any required Energy Commission flow-down provisions in each subcontract, in addition to a statement that the terms of this Agreement will prevail if they conflict with the subcontract terms.
- If required by the CAM, submit a draft of each *Subcontract* required to conduct the work under this Agreement.
- Submit a final copy of the executed subcontract.
- Notify and receive written approval from the CAM prior to adding any new subcontractors (see the discussion of subcontractor additions in the terms and conditions).

Products:

- Subcontracts *(draft if required by the CAM)*

TECHNICAL ADVISORY COMMITTEE

Subtask 1.10 Technical Advisory Committee (TAC)

The goal of this subtask is to create an advisory committee for this Agreement. The TAC should be composed of diverse professionals. The composition will vary depending on interest, availability, and need. TAC members will serve at the CAM's discretion. The purpose of the TAC is to:

- Provide guidance in project direction. The guidance may include scope and methodologies, timing, and coordination with other projects. The guidance may be based on:
  - Technical area expertise;

  - Knowledge of market applications; or
  - Linkages between the agreement work and other past, present, or future projects (both public and private sectors) that TAC members are aware of in a particular area.
- Review products and provide recommendations for needed product adjustments, refinements, or enhancements.
- Evaluate the tangible benefits of the project to the state of California, and provide recommendations as needed to enhance the benefits.
- Provide recommendations regarding information dissemination, market pathways, or commercialization strategies relevant to the project products.

The TAC may be composed of qualified professionals spanning the following types of disciplines:

- Researchers knowledgeable about the project subject matter;
- Members of trades that will apply the results of the project (e.g., designers, engineers, architects, contractors, and trade representatives);
- Public interest market transformation implementers;
- Product developers relevant to the project;
- U.S. Department of Energy research managers, or experts from other federal or state agencies relevant to the project;
- Public interest environmental groups;
- Utility representatives;
- Air district staff; and
- Members of relevant technical society committees.

The Recipient shall:

- Prepare a *List of Potential TAC Members* that includes the names, companies, physical and electronic addresses, and phone numbers of potential members. The list will be discussed at the Kick-off meeting, and a schedule for recruiting members and holding the first TAC meeting will be developed.
- Recruit TAC members. Ensure that each individual understands member obligations and the TAC meeting schedule developed in subtask 1.11.
- Prepare a *List of TAC Members* once all TAC members have committed to serving on the TAC.
- Submit *Documentation of TAC Member Commitment* (such as Letters of Acceptance) from each TAC member.

Products:

- List of Potential TAC Members
- List of TAC Members
- Documentation of TAC Member Commitment

Subtask 1.11 TAC Meetings

The goal of this subtask is for the TAC to provide strategic guidance for the project by participating in regular meetings, which may be held via teleconference.

Exhibit A
Scope of Work

The Recipient shall:

- Discuss the TAC meeting schedule with the CAM at the Kick-off meeting. Determine the number and location of meetings (in-person and via teleconference) in consultation with the CAM.
- Prepare a *TAC Meeting Schedule* that will be presented to the TAC members during recruiting. Revise the schedule after the first TAC meeting to incorporate meeting comments.
- Prepare a *TAC Meeting Agenda* and *TAC Meeting Back-up Materials* for each TAC meeting.
- Organize and lead TAC meetings in accordance with the TAC Meeting Schedule. Changes to the schedule must be pre-approved in writing by the CAM.
- Prepare *TAC Meeting Summaries* that include any recommended resolutions of major TAC issues.

Products:

- TAC Meeting Schedule (draft and final)
- TAC Meeting Agendas (draft and final)
- TAC Meeting Back-up Materials
- TAC Meeting Summaries

Exhibit A
Scope of Work

III. TECHNICAL TASKS

TASK 2. LED Component Development
The goal of this task is to develop compact, high-efficacy LED components for efficient light coupling into the lightguide. Novel LED primary optics will be designed and tested by Recipient, and efficient and stable inorganic downconverter materials will be evaluated in the effort to achieve very high efficacy (>185 lm/W) at color temperatures of 3000-3500K CCT (Correlated Color Temperature) and at high color quality (>90 Color Rendering Index [CRI], or equivalent). Much effort in this task will be focused on overcoming the historical trade-off between high efficacy and high color quality.

The Recipient shall:

- Design, simulate and fabricate LED primary optics geometries tailored for collimated emission.
- Test new primary optics designs by measuring efficacy as well as far-field intensity and color point vs. angle.
- Simulate and evaluate spectra for high color quality white light emission, while considering effects on package efficacy.
- Fabricate and measure LED components with predicted spectral and color quality characteristics, using measurements as refinement feedback for spectral modeling.
- Prepare quarterly LED Component Development reports on the progress towards achieving the goal of room-temperature “instant on” LED efficacy of >185 lm/W in the CCT and CRI ranges of interest (3000-3500K and >90, respectively).
- Month 24: Report final data meeting the program goal of LED component efficacy of >185 lm/W at room temperature, 3000-3500K CCT, >90 CRI, or equivalent.

Products:

- Quarterly LED Component Development Report.

TASK 3. Lightguide Light Coupling Lightguide coupling surface(s) and/or tailored optic(s) will be designed and tested by Recipient in conjunction with LED primary optics development. This combined approach will minimize the optical loss associated with conveying light from LEDs into the lightguide interior.

The Recipient shall:

- Design and simulate lightguide coupling optics that utilize the LED primary optics developed in Task 2 to achieve the system optical efficiency goals of the project.
- Fabricate optics prototypes and measure light coupling efficiency.
- Evaluate the implications of coupling optic design on eventual manufacturing by evaluating fabrication processes with regard to tolerances, yield, and estimated cost in volume production.
- Prepare quarterly Lightguide Light Coupling reports.
- By Month 18, report final data reaching the program goal of <5% optical loss from LEDs to the lightguide interior.

Products:

- Quarterly Lightguide Light Coupling Report

TASK 4. Lightguide Light Extraction

The goal of this task is to develop extraction features or optics on one or more lightguide surfaces, in order to efficiently extract light from the lightguide interior to the surrounding lit environment. In addition to extraction efficiency, the luminance (distribution over the lightguide surface) and illuminance (projected distribution to lit space) will be simulated and measured by Recipient.

The Recipient shall:

- Design and simulate lightguide extraction features/optics yielding an emission characteristic that enables an inter-luminaire spacing criterion of 1.0 – 1.2.
- Evaluate extraction feature geometries by simulating the effects of feature size, shape, and/or distribution on net light extraction efficiency.
- Fabricate light extraction features using techniques typically used in the LED industry, techniques Recipient has already developed, and/or new techniques Recipient develops under this agreement. Evaluate extraction features by quantifying extraction efficiency. Evaluate lightguide luminance and illuminance characteristics via visual observations and imaging. Compare with simulations to determine the effects of fabrication imperfections on actual emission characteristics.
- Evaluate the implications of extraction feature design for eventual manufacturing (high-volume fabrication processes).
- Prepare quarterly Lightguide Light Extraction reports.
- By Month 18, report final data meeting the program goal of <5% optical loss in extracting light from lightguide interior to its exterior (the lit space).

Products:

- Quarterly Lightguide Light Extraction Report

TASK 5. Electrical Circuitry, Drivers, Controls

In this task, Recipient will focus on the design of cost-effective, high-efficiency, and compact electrical power conversion drivers required for lightguide luminaires. By improving on existing circuit topologies, the electrical driver (for AC to DC power conversion) will have a compact, high-efficiency (95%+) design and optionally have the capability to interface with Cree wireless and other intelligent control systems.

The Recipient shall:

- Design and simulate high-efficiency, compact electrical drivers starting from existing high-efficiency (>90%) designs.
- Fabricate and test drivers as stand-alone units by quantifying power conversion efficiency and power factor.
- Design, fabricate, and test driver circuitry for interfacing with external control systems.
- Prepare quarterly Electrical Circuitry, Drivers, Controls reports
- By Month 18, report final data meeting the program goal of a compact driver design with >95% power conversion efficiency.

Products:

- Quarterly Electrical Circuitry, Drivers, Controls Report

TASK 6. Luminaire Integration, incl. Mechanical/Structural Elements

This task will address system-level requirements for thermal and mechanical components for a demonstration luminaire integrating the subsystems developed in task 2. The luminaire will be designed by Recipient to minimize cost and weight, while combining functionalities wherever possible. By the end of the project, a representative luminaire will be designed, fabricated, and assembled to exhibit the advantages of the novel subsystems developed during the project.

The Recipient shall:

- Design and simulate a full-scale demonstration luminaire incorporating the proposed lightguide architecture, including the compact, high-efficiency driver designed in Task 5.
- Develop manufacturable thermal (if any) and mechanical subsystem designs, with an emphasis on single-piece designs with low assembly complexity. Minimize prospective bill of materials and assembly costs by combining functionalities (*e.g.* thermal + mechanical) and minimizing piece-part count.
- Fabricate and test demonstration luminaire design by quantifying net 'steady state' efficacy in calibrated integrating spheres. Some fabrication activities may be outsourced to vendors.
- Confirm that a steady-state (thermally equilibrated) luminaire efficacy of >150 lm/W can be reached in a CCT range of 3000-3500K and color rendering index of >90.
- Prepare quarterly Luminare Integration, incl. Mechanical/Structural Elements reports.
- By End of Project, report on a fully integrated lightguide luminaire meeting or exceeding a steady-state efficacy of 150 lm/W at 3000-3500K CCT and >90 CRI or equivalent.
- Participate in a CPR meeting and prepare CPR Report #1 in accordance with subtask 1.3 (CPR Meetings).

Products:

- Quarterly Luminare Integration, including Mechanical/Structural Elements Report.
- CPR Report

TASK 7. Evaluation of Project Benefits

The goal of this task is to report the benefits resulting from this project.

The Recipient shall:

- Complete three Project Benefits Questionnaires that correspond to three main intervals in the Agreement: (1) *Kick-off Meeting Benefits Questionnaire*; (2) *Mid-term Benefits Questionnaire*; and (3) *Final Meeting Benefits Questionnaire*.
- Provide all key assumptions used to estimate projected benefits, including targeted market sector (e.g., population and geographic location), projected market penetration, baseline and projected energy use and cost, operating conditions, and emission reduction calculations. Examples of information that may be requested in the questionnaires include:

    - <u>For Product Development Projects and Project Demonstrations:</u>
        - Published documents, including date, title, and periodical name.
        - Estimated or actual energy and cost savings, and estimated statewide energy savings once market potential has been realized. Identify all assumptions used in the estimates.
        - Greenhouse gas and criteria emissions reductions.

- Other non-energy benefits such as reliability, public safety, lower operational cost, environmental improvement, indoor environmental quality, and societal benefits.
- Data on potential job creation, market potential, economic development, and increased state revenue as a result of the project.
- A discussion of project product downloads from websites, and publications in technical journals.
- A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
- Additional Information for Product Development Projects:
    - Outcome of product development efforts, such copyrights and license agreements.
    - Units sold or projected to be sold in California and outside of California.
    - Total annual sales or projected annual sales (in dollars) of products developed under the Agreement.
    - Investment dollars/follow-on private funding as a result of Energy Commission funding.
    - Patent numbers and applications, along with dates and brief descriptions.
- Additional Information for Product Demonstrations:
    - Outcome of demonstrations and status of technology.
    - Number of similar installations.
    - Jobs created/retained as a result of the Agreement.

o For Information/Tools and Other Research Studies:

- Outcome of project.
- Published documents, including date, title, and periodical name.
- A discussion of policy development. State if the project has been cited in government policy publications or technical journals, or has been used to inform regulatory bodies.
- The number of website downloads.
- An estimate of how the project information has affected energy use and cost, or have resulted in other non-energy benefits.
- An estimate of energy and non-energy benefits.
- Data on potential job creation, market potential, economic development, and increased state revenue as a result of project.
- A discussion of project product downloads from websites, and publications in technical journals.
- A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.

- Respond to CAM questions regarding responses to the questionnaires.

The Energy Commission may send the Recipient similar questionnaires after the Agreement term ends. Responses to these questionnaires will be voluntary.

Products:

- Kick-off Meeting Benefits Questionnaire
- Mid-term Benefits Questionnaire
- Final Meeting Benefits Questionnaire

TASK 8. Technology/Knowledge Transfer Activities

The goal of this task is to develop a plan to make the knowledge gained, experimental results, and lessons learned available to the public and key decision makers.

The Recipient shall:

- Prepare an *Initial Fact Sheet* at start of the project that describes the project. Use the format provided by the CAM.
- Prepare a *Final Project Fact Sheet* at the project's conclusion that discusses results. Use the format provided by the CAM.
- Prepare a *Technology/Knowledge Transfer Plan* that includes:
  - An explanation of how the knowledge gained from the project will be made available to the public, including the targeted market sector and potential outreach to end users, utilities, regulatory agencies, and others.
  - A description of the intended use(s) for and users of the project results.
  - Published documents, including date, title, and periodical name.
  - Copies of documents, fact sheets, journal articles, press releases, and other documents prepared for public dissemination. These documents must include the Legal Notice required in the terms and conditions. Indicate where and when the documents were disseminated.
  - A discussion of policy development. State if project has been or will be cited in government policy publications, or used to inform regulatory bodies.
  - The number of website downloads or public requests for project results.
  - Additional areas as determined by the CAM.
- Conduct technology transfer activities in accordance with the Technology/Knowledge Transfer Plan. These activities will be reported in the Progress Reports.
- When directed by the CAM, develop *Presentation Materials* for an Energy Commission-sponsored conference/workshop on the results of the project.
- Prepare a *Technology/Knowledge Transfer Report* on technology transfer activities conducted during the project.

Products:

- Initial Fact Sheet (draft and final)
- Final Project Fact Sheet (draft and final)
- Presentation Materials (draft and final)
- Technology/Knowledge Transfer Plan (draft and final)
- Technology/Knowledge Transfer Report (draft and final)

TASK 9. Production Readiness Plan

The goal of this task is to determine the steps that will lead to the manufacturing of technologies developed in this project or to the commercialization of the project's results.

The Recipient shall:

Exhibit A
Scope of Work

- Prepare a *Production Readiness Plan*. The degree of detail in the plan should be proportional to the complexity of producing or commercializing the proposed product, and to its state of development. As appropriate, the plan will discuss the following:
  - Critical production processes, equipment, facilities, personnel resources, and support systems needed to produce a commercially viable product.
  - Internal manufacturing facilities, supplier technologies, capacity constraints imposed by the design under consideration, design-critical elements, and the use of hazardous or non-recyclable materials. The product manufacturing effort may include "proof of production processes."
  - The estimated cost of production.
  - The expected investment threshold needed to launch the commercial product.
  - An implementation plan to ramp up to full production.
  - The outcome of product development efforts, such as copyrights and license agreements.
  - Patent numbers and applications, along with dates and brief descriptions.
  - Other areas as determined by the CAM.

Products:

- Production Readiness Plan (draft and final)

Exhibit A
Scope of Work

IV. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.

RESOLUTION NO: 15-0225-14f

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION - RE: CREE, INC.

RESOLVED, that the State Energy Resources Conservation and Development Commission (Energy Commission) adopts the staff CEQA findings contained in the Agreement Request Form; and

RESOLVED, that the Energy Commission approves Agreement EPC-14-014 with CREE, Inc. for a $2,774,920 grant to develop high-efficacy, low-cost LED luminaires based on a novel light guide optics architecture; and

FURTHER BE IT RESOLVED, that the Executive Director or his/her designee shall execute the same on behalf of the Energy Commission.

CERTIFICATION

The undersigned Secretariat to the Commission does hereby certify that the foregoing is a full, true, and correct copy of a Resolution duly and regularly adopted at a meeting of the California Energy Commission held on February 25, 2015.

AYE: [List of Commissioners]
NAY: [List of Commissioners]
ABSENT: [List of Commissioners]
ABSTAIN: [List of Commissioners]

Harriet Kallemeyn,
Secretariat