STATE OF CALIFORNIA

# GRANT REQUEST FORM (GRF)

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

New Agreement EPC-14-008 (To be completed by CGL Office)

| Division | Agreement Manager: | MS- | Phone |
|---|---|---|---|
| ERDD | Zhiqin (Jessica) Zhang | 43 | 916-327-1397 |

| Recipient's Legal Name | Federal ID Number |
|---|---|
| The Regents of the University of California, San Diego | 95-2872494 |

| Title of Project |
|---|
| Solar Forecast Based Optimization of Distributed Energy Resources in the LA Basin and UC San Diego Microgrid |

| Term and Amount | Start Date | End Date | Amount |
|---|---|---|---|
| | 1/15/2015 | 3/15/2018 | $ 999,984 |

**Business Meeting Information**

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

| | | | |
|---|---|---|---|
| Proposed Business Meeting Date | 12/10/2014 | ☐ Consent | ☒ Discussion |
| Business Meeting Presenter | Zhiqin (Jessica) Zhang | Time Needed: | 5 minutes |

Please select one list serve. Select

**Agenda Item Subject and Description**

Proposed resolution approving Agreement EPC-14-008 with The Regents of the University of California on behalf of the San Diego campus for a $999,984.00 grant to optimize energy storage charge / discharge, electric vehicle charging with bi-directional communication, and demand to reduce peak electricity load, increase electricity reliability, reduce ratepayer cost, and increase electricity safety. The goal will be accomplished by developing emerging utility-scale renewable energy integration technologies and strategies through improving the accuracy of solar forecasting technologies, increasing the value of distributed energy resources (DERs), and achieving near real-time optimal control of DERs. Contact: (Zhiqin Zhang) EPIC funding

**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 project will not have a significant effect on the environment.
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 |
|---|---|
| | $ |
| | $ |
| | $ |
| | $ |
| | $ |
| | $ |
| | $ |
| | $ |
| | $ |

STATE OF CALIFORNIA

# GRANT REQUEST FORM (GRF)

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

| **List all key partners:** (attach additional sheets as necessary) |
|---|
| Legal Company Name: |
| San Diego Gas & Electric Company |
| |
| |
| |

| **Budget Information** | | | |
|---|---|---|---|
| **Funding Source** | **Funding Year of Appropriation** | **Budget List No.** | **Amount** |
| EPIC | 13-14 | 301.001A | $999,984 |
| | | | $ |
| | | | $ |
| | | | $ |
| | | | $ |
| | | | $ |
| R&D Program Area: EGRO: Renewables | | TOTAL: | $999,984 |
| Explanation for "Other" selection | | | |
| Reimbursement Contract #: | | Federal Agreement #: | |

| **Recipient's Administrator/ Officer** | | | | **Recipient's Project Manager** | | | |
|---|---|---|---|---|---|---|---|
| Name: | Lynelle Gehrke | | | Name: | Jan Kleissl | | |
| Address: | 9500 GILMAN DR | | | Address: | 9500 GILMAN DR | | |
| City, State, Zip: | LA JOLLA, CA 92093-5004 | | | City, State, Zip: | LA JOLLA, CA 92093-5004 | | |
| Phone: | 858-534-0243 / | Fax: | - - | Phone: | / | Fax: | - - |
| E-Mail: | LGehrke@ucsd.edu | | | E-Mail: | | | |

| **Selection Process Used** | |
|---|---|
| ☒ Competitive Solicitation | Solicitation #: PON-13-303 |
| ☐ 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 Template

### A. Task List

| Task # | CPR[1] | Task Name |
|---|---|---|
| 1 | | General Project Tasks |
| 2 | | Short-term to Long-term Forecast Models for DNI and POA Irradiance |
| 3 | X | RTP Generation Forecast |
| 4 | | Optimization and Deployment of Network of Sensors at CVSR |
| 5 | | Application of the Developed Tools to Other Solar Plants (Non-Concentrating) |
| 6 | | Evaluation of Project Benefits |
| 7 | | Technology/Knowledge Transfer Activities |

### B. Acronym/Term List

| Acronym/ Term | Meaning |
|---|---|
| CAM | Commission Agreement Manager |
| CAO | Commission Agreement Officer |
| CPR | Critical Project Review |
| CPV | Concentrated Photovoltaic |
| CSP | Concentrated Solar Power |
| CVSR | California Valley Solar Ranch |
| DNI | Direct Normal Irradiance |
| GHI | Global Horizontal Irradiance |
| MW | Megawatt |
| NWP | Numerical Weather Prediction |
| POA | Plane Of Array |
| PV | Photovoltaic |
| RTP | Resource To Power |
| TAC | Technical Advisory Committee |
| WRF | Weather Research and Forecasting |

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

### A. Purpose of Agreement

The purpose of this Agreement is to fund applied research to address important technological gaps in the forecasting of direct normal irradiance (DNI), plane of array (POA) irradiance and solar power generation using concentrated solar power (CSP), concentrated photovoltaic (CPV), and photovoltaic (PV) tracking technologies. The tools developed in this project will be tested and validated at utility-scale solar plants including 392 MW Ivanpah Solar using CSP technology and California Valley Solar Ranch (CVSR) using tracking PV technology.

[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.

## B. Problem/ Solution Statement

**Problem**

While forecasting models for fixed PV technologies are already well established, the same is not true for solar technologies such as CSP, CPV or PV tracking. Power generation in these cases relies on DNI and POA irradiance, which are the most difficult components of the solar resource to forecast due to their high vulnerability from cloud and aerosol transmittance effects. The lack of forecast models for these quantities is well illustrated by the small number of DNI/POA irradiance forecast algorithms discussed in the scientific literature, and the absence of DNI forecasts from the various numerical weather prediction (NWP) models. In contrast, forecast algorithms for wind and global horizontal irradiance (GHI), on which fixed PV relies, abound in the literature and are available from several solar and wind forecasting services.

**Solution**

The recipient will develop and validate forecast and resource to power (RTP) models optimized for DNI, POA irradiance and solar power generation. The DNI and POA irradiance forecasts will be developed for all relevant time horizons for this project. The new forecast system will concatenate all the inputs from sky imaging, remote sensing, NWP and weather research and forecasting (WRF) within the same forecasting engine methodology using a host of techniques from machine learning to big-data analysis to create high-fidelity forecasts for horizons from 5 minutes to 72 hours into the future. By distributing a network of sensors over the solar fields, the enhanced spatial resolution will be incorporated in the determination of the resource forecasts. The performance of the tools developed will be demonstrated at two large centralized solar plants: Ivanpah and CVSR. These two plants alone account for more than 10% of the PV solar capacity in California. The RTP model to be developed will be used to analyze the large, complex data collected from the solar plants' sensor network and to investigate multivariate, non-linear relationships between behavioral characteristics in order to foster the optimization of the prediction of plant power output.

## C. Goals and Objectives of the Agreement

**Agreement Goals**

The goals of this agreement are to:

- Address the lack of forecasting tools for DNI, POA irradiance and RTP for CSP, CPV, or PV tracking technologies.
- Develop and validate forecast and RTP models optimized for DNI, POA irradiance and solar power generation for large centralized power plants.
- Reduce the uncertainty on the power output of centralized solar power plants.

Ratepayer Benefits:[2] This Agreement will result in the ratepayer benefits of greater reliability and lower costs by decreasing generation uncertainty and outage penalties from the utilities, which eventually trickle down to the ratepayer.

[2] 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).

This project has the ability to substantially affect the effective solar capacity in California by decreasing the number of forced outages, associate ancillary reserves and utility fines that impact substantially the reliability and the effective cost of solar generation, and directly impacts public perception of solar power generation. Particularly for Ivanpah, an unpredicted ramp in DNI across the solar field can trip all 3 towers in the plant, and due to warm-up times associated with the auxiliary boilers, disable power generation for the rest of the day. Because of the size of the plant, if the solar forecasting skill is increased by only 10% across all time horizons for a single week in the year, the total cost of this 3-year project is recovered in terms of outage penalties and peak-shaving differential costs associated with spinning reserves.

Technological Advancement and Breakthroughs:[3] This Agreement will lead to technological advancement and breakthroughs by developing and validating tools capable of monitoring and forecasting the local solar DNI and POA accurately so that the reliable RTP models can be developed for operation, scheduling, and market participation. This is especially critical and challenging during times when the solar resource is highly variable due to the presence of cloud and aerosol effects. The forecasting tool will take into consideration the position of the sun, clouds, and plant location such that forecasting solar resources will be accurate even during times when weather conditions induce high variability for the solar resource.

**Agreement Objectives**

The objectives of this Agreement are to:

- Improve DNI and POA irradiance forecasting accuracy;
- Improve the RTP model for the Ivanpah CSP and CVSR plants;
- Deploy and test a new generation of forecasting systems at these 2 plants;
- Develop control strategies for partially cloudy conditions (allowing operators to “ride” the transients without tripping the plant, particularly at Ivanpah);
- Generalize the models and algorithms to other/future CSP plants and other solar technologies (CPV, PV tracking);
- Assess the benefits of these new tools to the California ratepayers.

[3] 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.

# Exhibit A
# Scope of Work Template

## 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.

# Exhibit A
# Scope of Work Template

**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)

# Exhibit A
# Scope of Work Template

## *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.

# Exhibit A
# Scope of Work Template

**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.

**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

## III. TECHNICAL TASKS

*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. **Subtask 1.1 (Products)** describes the procedure for submitting products to the CAM.*

**TASK 2 Short-term to Long-term Forecast Models for DNI and POA Irradiance**
The goal of this task is to improve forecasting algorithms for solar irradiance with emphasis on DNI and POA irradiance from short-term to long-term horizons (from 5 minutes to 72 hours).

**SUBTASK 2.1 DNI and POA Irradiance Forecast Intra-hour Forecast Models**
The goal of this subtask is to develop intra-hour forecast models for DNI and POA irradiance. Emphasis will be placed on improving the forecast accuracy during periods of highly variable irradiance fluctuations, such as in cloudy periods.

**The Recipient shall:**

- Develop short-term forecast models. Applied research performed in this task includes but is not limited to:
    - Developing deterministic and machine-learning tools to ingest and process cloud cover information in order to forecast all components of the solar resource in the short-term.
- Develop sky imager-assisted forecast models. This will be accomplished by:
    - Improving cloud detection and cloud motion algorithms in order to predict cloud direction of motion and speed of cloud travel.
- Submit an *Intra-hour Solar Resource Forecast Performance Report*. The report shall include, but not be limited to, the short-term forecast modes and the sky imager-assisted forecast models developed under this task.
- Develop a Web Portal for the intra-hour forecast models which provides real time forecast and forecast performance for the intra-hour models.
- Submit a *Summary Report on the Web Portal for the Intra-hour Solar Forecast Models* which shall include website links and a summary on how much the DNI and POA irradiance forecast accuracy are improved during periods of highly variable irradiance fluctuations using intra-hour forecast models.

**Products:**

- Intra-hour Solar Resource Forecast Performance Report
- Summary Report on the Web Portal for the Intra-hour Solar Forecast Models

**SUBTASK 2.2 DNI and POA Irradiance Forecast Intra-day Forecast Models**
The goal of this subtask is to develop intra-day forecast models for DNI and POA irradiance.

**The Recipient shall:**

- Develop medium-term forecast models.
- Create forecasting tools based on cloud fields from visible and infrared remote sensing images to predict irradiance up to 6-hours in advance (intra-day horizons).

- Submit an *Intra-day Solar Resource Forecast Performance Report*. The report shall include, but not be limited to, the medium-term forecast models and forecasting tools based on cloud fields from visible infrared remote sensing images developed under this task.
- Develop a Web Portal for the intra-day solar resource forecast models which provides real time forecast and forecast performance for the intra-day models.
- Submit a *Summary Report on the Web Portal for the Intra-day Solar Forecast Models* which shall include website links and a summary on how much the DNI and POA irradiance forecast accuracy are improved during periods of highly variable irradiance fluctuations using intra-hour forecast models.

**Products:**
- Intra-day Solar Resource Forecast Performance Report
- Summary Report on the Web Portal for the Intra-day Solar Forecast Models

**SUBTASK 2.3 DNI and POA Irradiance Forecast Day-ahead Forecast Models**
The goal of this subtask is to optimize day-ahead forecast models for DNI and POA irradiance.

**The Recipient shall:**
- Deploy the UC San Diego, WRF-Solar CA model for Ivanpah's location.
- Optimize the performance of day-ahead forecast for Ivanpah with:
    - Model output statistics (MOS) correction and machine learning applied to Numerical weather predictions (ex: NAM, WRF, etc.)
- Develop and submit a *Day-Ahead Solar Resource Forecast Performance Report.* The report shall include, but not be limited to, deployment of the WRF-Solar CA model and optimization of the performance of day-ahead forecast for Ivanpah, performed under this task.
- Submit a *Summary Report on the Web Portal for the Day-ahead Solar Resource Forecast Models* which provides real time forecast and forecast performance for the day-ahead forecast models. The report shall include website links and a summary on how much the DNI and POA irradiance forecast accuracy are improved during periods of highly variable irradiance fluctuations using day-ahead forecast models.

**Products:**
- Day-Ahead Solar Resource Forecast Performance Report
- Summary Report on the Web Portal for the Day-ahead Solar Forecast Models

**SUBTASK 2.4 Validation and Verification of the Forecast Models**
The goal of this subtask is to validate the forecast models developed in the previous subtasks.

**The Recipient shall:**
- Compare the forecasting results for the various forecast horizons against ground data.
- Compute the performance metrics that allow quantifying the forecast improvement.
- Identify deficiencies in the developed forecast models and implement measures to correct them.

- Submit a *Validation, Verification And Optimization Of The Developed Solar Resource Forecast Models Report.* The report shall include, but not be limited to, all activities performed under this task.

**Products:**

- Validation, Verification And Optimization Of The Developed Solar Resource Forecast Models Report (Draft and Final)

**TASK 3 RTP Generation Forecast**

The goal of this task is to develop RTP forecast models for Ivanpah. The models will ingest the forecast from the tools developed in task 2.

**SUBTASK 3.1 Develop Wind Surface Forecast Models**

The goal of this subtask is to develop surface wind forecasts for Ivanpah. Wind speed is an important variable in the operation of Ivanpah as high wind speeds prevent the heliostats from proper alignment.

**The Recipient shall:**

- Apply model output statistics (MOS) correction and machine learning numerical weather predictions (smart NAM, WRF, etc.) to improve surface wind forecasts for Ivanpah.
- Compare the forecasting results for the various forecast horizons against ground wind data.
- Compute the performance metrics that allow quantifying the forecast improvement.
- Identify deficiencies in the forecast models and implement measures to correct them.
- Submit a *Validation, Verification and Optimization of the Developed Wind Forecast Model Report.* The report shall include, but not be limited to, all activities performed under this task.

**Products:**

- Validation, Verification and Optimization of the Developed Wind Forecast Model Report (Draft and Final)

**SUBTASK 3.2 Development of a Model for the Operational Behavior of Ivanpah**

The goal of this task is to develop new, feature selection and prediction methodology to analyze the large, complex data collected from the solar plant's sensor network to investigate multivariate, non-linear relationships between behavioral characteristics in order to foster the optimization of the overall power output.

**The Recipient shall:**

- Analyze the events that are anomalous from existing operations.
- Develop machine-learning methods to automatically detect patterns in data, and then use the uncovered patterns to predict future data, and help in decision-making under uncertainty.
- Develop tools to detect and alert on suboptimal settings and behaviors in real-time throughout the extended system.
- Submit a *Report on Settings and Behaviors That Lead to Suboptimal Plant Operation.*

- Submit a *Report on Detailing Measures to Improve the Decision Making Process Under Uncertainty.*

**Products:**

- Report on Settings and Behaviors That Lead to Suboptimal Plant Operation (Draft and Final)
- Report on Detailing Measures to Improve the Decision Making Process Under Uncertainty (Draft and Final)

**SUBTASK 3.3 Resource To Power (RTP) Model**

The goal of this subtask is to integrate the tools developed in the previous subtasks and the tools developed in task 2 to create an optimized model for the power generation at Ivanpah.

**The Recipient shall:**

- Create a power generation forecasting model that integrates the resource forecast, the wind forecast and the optimized operational behavior model for Ivanpah
- Compare the RTP model results against Ivanpah's power output.
- Compute the performance metrics that allow quantifying the forecast improvement.
- Identify deficiencies in the forecast models and implement measures to correct them.
- Develop control strategies to reduce Ivanpah's trips from cloud transients and maximize plant's performance.
- Submit a *Report Addressing the Validation, Verification and Optimization of the Developed Solar Resource Forecast Models*.
- Prepare a *CPR Report* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting.

**Products:**

- Report Addressing the Validation, Verification and Optimization of the Developed Solar Resource Forecast Models (Draft and Final)
- CPR Report

**TASK 4 Optimization and Deployment of Network of Sensors at CVSR**

The goal of this task is to optimize and deploy data acquisition tools to monitor sky conditions and solar irradiance at CVSR.

**The Recipient shall:**

- Integrate sky-camera and irradiance sensors into BeagleBone board to obtain real time, high-resolution sky-images and high-frequency irradiance measurements.
- Integrate a line-of-sight wireless bridge into the BeagleBones to allow for retrieving the sensors' data across the CVSR solar field.
- Deploy, test and optimize the sensor prototype installed in this project under real conditions at the CVSR solar field.
- Acquire the parts to replicate the sensor prototype. Upon determining the best architecture for the low cost sensors, build 40 sensors that will serve as nodes in the network of sensors.
- Deploy sensors across the CVSR solar field.
- Assess of the performance of the network of sensors in real-time under real conditions.

- Submit a *Sensor Network Design And Specifications Report*.
- Submit a *Field Test Performance for the Network of Sensors Report.*

**Products:**
- Sensor Network Design And Specifications Report (Draft and Final)
- Field Test Performance For The Network Of Sensors Report (Draft and Final)

**TASK 5 Application of Developed Tools to Other Solar Plants (Non-Concentrating)**
The goals of this task are to apply the tools developed in tasks 2 and 3 to the non-concentrating CVSR solar farm and to incorporate the data from the network of sensors (task 4) into the forecast models.

**The Recipient shall:**
- Assess how the findings of tasks 2 and 3 can be generalized for other CSP projects.
- Apply the NDI, POA and RTP forecasting models to PV tracking solar farm's power output data.
- Deploy of the irradiance forecast models to the CVSR PV tracking solar farm.
- Develop the RTP forecasts for the CVSR PV tracking solar farm.
- Compare the resource and power forecast for CVSR against telemetry.
- Assess how the findings from CVSR can be generalized for other PV and CPV projects.
- Submit a *Validation, Verification and Optimization of the Developed Solar Resource and Power Generation Forecast Models for CVSR Report.*
- Submit a *Applicability of the Developed Tools for Other Centralized Solar Power Plants Report*

**Products:**
- Validation, Verification and Optimization of the Developed Solar Resource and Power Generation Forecast Models for CVSR Report (Draft and Final)
- Applicability Of The Developed Tools For Other Centralized Solar Power Plants Report (Draft and Final)

**TASK 6 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:

    - o <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 7 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)

## IV. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.

**RESOLUTION NO: 14-1210-13g**

**STATE OF CALIFORNIA**

**STATE ENERGY RESOURCES**
**CONSERVATION AND DEVELOPMENT COMMISSION**

RESOLUTION - RE: THE REGENTS OF THE UNIVERSITY OF CALIFORNIA, SAN DIEGO

**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-14-008 with **The Regents of the University of California on behalf of the San Diego campus** for a **$999,898** grant to address a lack of accurate solar energy forecasting tools for concentrated solar power, concentrated PV and PV tracking technologies by developing solar forecasting and resource-to-power models optimized for direct normal irradiance plane of array irradiance, and solar power generation and validating these models at the utility-scale solar plants including 392 MW Ivanpah Solar and 250 MW California Valley Solar Ranch; 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 December 10, 2014

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

Harriet Kallemeyn,
Secretariat