

GRANTS/CONTINGENT AWARD REQUEST

CEC-270 (Revised 02/10)

CALIFORNIA ENERGY COMMISSION



To: Grants and Loans Office

Date: 2/28/2013

Project Manager: Michael Sokol

Phone Number: 916-327-1416

Office: Energy Generation Research Office

Division: Energy Research and Development

MS- 43

Project Title: Predictable Solar Power and Smart Building Management for California Communities

Type of Request: (check one)

New Agreement: (include items A-F from below) Agreement Number: PIR-12-016

Program: PIER E / Renewables

PON-12-502-25 (Community Scale Renewable Energy Development,
Solicitation Name and/or Number: Deployment and Integration)

Legal Name of Recipient: Cool Earth Solar, Inc.

Recipient's Full Mailing Address: 4659 LAS POSITAS RD STE C
LIVERMORE, CA 94551-9631

Recipient's Project Officer: Tony Chen Phone Number: 925-454-8506

Agreement Start Date: 6/19/2013 Agreement End Date: 3/31/2015

Amendment: (Check all that apply) Agreement Number: _____

Term Extension – New End Date: _____

Work Statement Revision (include Item A from below)

Budget Revision (include Item B from below)

Change of Scope (include Items A – F as applicable from below)

Other: _____

ITEMS TO ATTACH WITH REQUEST:

- A. Work Statement
- B. Budget
- C. Recipient Resolution, if applicable. (Resolution may be requested in Special Conditions if not currently available.)
- D. Special Conditions, if applicable.
- E. CEQA Compliance Form
- F. Other Documents as applicable
 - Copy of Score Sheets
 - Copy of Pre-Award Correspondence
 - Copy of All Other Relevant Documents

California Environmental Quality Act (CEQA)

CEC finds, based on recipient's documentation in compliance with CEQA:

Project exempt: _____ NOE filed: _____

Environmental Document prepared: _____ NOD filed: _____

Other: _____

CEC has made CEQA finding described in CEC-280, attached

Funding Information:

*Source #1: PIER-E Amount: \$ 1,726,438.00 Statute: 11- FY: 12-13 Budget List #: 501.027J

*Source #2: _____ Amount: \$ Statute: _____ FY: _____ Budget List #: _____

*Source #3: _____ Amount: \$ Statute: _____ FY: _____ Budget List #: _____

If federally funded, specify federal agreement number: _____

* Source Examples include ERPA, PIER-E, PIER-NG, FED, GRDA, ARFVT, OTHER.

Business Meeting Approval: (refer to Business Meeting Schedule)

Proposed Business Meeting Date: 5/8/2013 Consent Discussion

Business Meeting Participant: Michael Sokol Time Needed: 5 minutes

Agenda Notice Statement: (state purpose in layperson terms)

Possible approval of a Grant / Contingent Award to...

Possible approval of this agreement grant number PIR-12-016 with Cool Earth Solar, Inc. to demonstrate an innovative community-based clean energy system that includes cutting-edge concentrating photovoltaics (CPV), a novel high-resolution solar forecast model that utilizes an Energy Commission-funded sky imager technology, and an active building energy management system to increase efficiency and energy security in Open Campus (LVOC) community in the amount of \$1,726,438.00. The length of this agreement is 22 months.

Exhibit A WORK STATEMENT

TECHNICAL TASK LIST

Task #	CPR	Task Name
1	N/A	ADMINISTRATION
2		INSTALL AND OPERATE 100 KW OF CPV ARRAYS
2.1		Order / Manufacture CPV Arrays, Phase I
2.2		Prepare LVOC Site for Construction and Installation of CPV Arrays
2.3	X	Install and Operate Phase I of CPV Arrays
2.4		Order / Manufacture CPV Arrays, Phase II
2.5		Install and Operate Phase II of CPV Arrays
3		DEPLOY NETWORKED ARRAY OF SKY IMAGERS
3.1		Prepare Sites for Installation of Met Stations
3.2		Assemble and Test 14 Met stations
3.3		Install and Operate Met Stations
4		DEVELOP, TEST, AND DEMONSTRATE SOLAR POWER FORECAST MODEL
4.1		Develop PV Power Model of CPV Installation
4.2		Develop Solar Forecast Engine with Imager and Satellite Data Input
4.3		Validate Power Forecasts with CPV Installation Collector Data
5		OPTIMIZE BUILDING ENERGY MANAGEMENT USING ENVIRONMENTAL FORECASTS
5.1		Develop Predictive Building Energy Use Model
5.2		Develop Forecast of Environmental Building Energy Loads
5.3		Demonstrate Building Energy Reduction Using Environmental Forecasts
6		OUTREACH
7		TECHNOLOGY TRANSFER ACTIVITIES
8		PRODUCTION READINESS PLAN

KEY NAME LIST

Task #	Key Personnel	Key Subcontractor(s)	Key Partner(s)
1	Dr. Paul Dentinger (Cool Earth Solar)	Lawrence Livermore National Laboratory	
2	Dr. Paul Dentinger (Cool Earth Solar)		Sandia National Laboratories
3	Dr. Paul Dentinger (Cool Earth Solar)		Sandia National Laboratories
4	Dr. Wayne O. Miller (Lawrence Livermore National Laboratory)	Lawrence Livermore National Laboratory	
5	Dr. A.J. Simon (Lawrence Livermore National Laboratory)	Lawrence Livermore National Laboratory	Sandia National Laboratories
6	Dr. Paul Dentinger (Cool Earth Solar)	Lawrence Livermore National Laboratory	Sandia National Laboratories

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Task #	Key Personnel	Key Subcontractor(s)	Key Partner(s)
7			
8	Dr. Paul Dentinger (Cool Earth Solar)	Lawrence Livermore National Laboratory	

GLOSSARY

Specific terms and acronyms used throughout this scope of work are defined as follows:

Term/ Acronym	Definition
Array	With regard to Cool Earth Solar's CPV technology an array is one complete Cool Earth Solar CPV system. It includes multiple CPV modules mounted on a dual-axis tracking structure. This term is used interchangeably with the term "rig."
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CPR	Critical Project Review
CPV	Concentrated Photovoltaic: solar electricity technology that focuses light at higher optical concentrations onto solar cells
DNI	Direct Normal Irradiance: the amount of solar radiation from the direction of the sun. Synonymous with beam irradiation.
GOES WEST	Geostationary Satellite. The GOES series of satellites is owned and operated by the National Oceanic and Atmospheric Administration which provides a long-term archive of GOES data and real time data. The GOES WEST spacecraft at 135.0 Longitude provides weather data for the western United States and the Pacific Basin.
HVAC	Heating, Ventilation, and Air Conditioning
kW	Kilowatt: a power rating equal to one thousand watts where one watt is the rate at which work is done when an object's velocity is held constant at one meter per second against constant opposing force of one Newton.
kWh	kilowatt hour: a unit of energy equivalent to one kilowatt (1 kW) of power expended for one hour (1 h) of time
LLNL	Lawrence Livermore National Laboratory
LVOC	Livermore Valley Open Campus
Met station	Meteorological station
Micro grid	A localized grouping of electricity generation, energy storage, and loads that normally operates connected to a traditional centralized grid
NCAR	The National Center for Atmospheric Research: a federally funded research and development center devoted to service, research and education in the atmospheric and related sciences.
O&M	Operations and Maintenance
Peak Load	The maximum instantaneous load or the maximum average load on an electrical power-supply system over a designated interval of time. Also known as peak power.
Performance ratio	As used in solar operations, the performance ratio indicates the actual amount of solar power produced by a module or system in comparison to the maximum possible power output.
PIER	The Energy Commission's Public Interest Energy Research (PIER) Program
PV	Photovoltaic

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Term/ Acronym	Definition
Pyranometer	An instrument for measuring radiation from the sky by comparing the heating effect of such radiation upon two blackened metallic strips with that produced in the same strips when heated by means of an electric current.
Rated capacity	This is the maximum expected output capacity of each solar module under standard test conditions (STC). Standard test conditions for CPV usually mean 900 Watts per square meter of solar irradiation striking the module and a cell temperature of 25 degrees Celsius.
Receiver	A device, such as a part of a PV or CPV module, that receives incoming light and converts it into electricity
Refraction	The change of direction of a ray of light in passing obliquely from one medium into another in which its wave velocity is different.
Rig	One rig is one complete Cool Earth Solar CPV system. It includes multiple CPV modules mounted on a dual-axis tracking structure.
River Islands	A California community under development in Lathrop, CA.
RMSE	Root-Mean-Square Error. A measure of the differences between values predicted by a model or an estimator and the values actually observed. Its range is from 0 to infinity, with 0 being a perfect score
SCADA	Supervisory control and data acquisition: the software and database that controls the solar installation and collects operational and performance data from the installation
Sky imager	Generally, a camera-based device that takes images of the sky over time. These images are used to convey information about cloud opacity, speed, direction, etc. In this Agreement, the term is used interchangeably with the term "met station" to refer to Cool Earth Solar's solar resource measurement and cloud tracking device.
System rated capacity	The system rated capacity is the product of the total number of modules installed and the rated capacity of each module. The system rated capacity is given in kilowatts _{DC} or Watts _{DC} .

Problem Statement:

Throughout California there are community centers, office parks, research facilities, factories and planned communities that have acreage suitable for community scale ground-mounted solar and can take advantage of solar forecasting, and energy management. These large population community hubs can use locally available renewable energy resources to improve air quality, expand community adoption of renewable energy, support community adoption of plug-in electric vehicles, reduce total energy consumption, and utilize weather and renewable energy forecast software to shave peak load demand. The project seeks to demonstrate a repeatable model of a full value chain for generating solar energy, forecasting that solar generation, and developing proactive building energy management tools to adapt to that forecast. In this demonstration, the predictable solar electricity generation used to provide renewable electricity to the community will additionally support electric vehicle use within the same community.

Given the excellent solar resource in California, it makes sense to consider concentrating photovoltaic systems for ground mounted community systems. Such concentrated photovoltaic (CPV) systems can provide solar energy at lower costs. On the other hand, they become more impacted by intermittent sunlight. However, this can be mitigated through accurate forecasting of sunlight using sensors that a community project can afford. California should understand the

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feasibility of implementing community scale CPV including forecasting and ultimate energy usage. This project seeks to address that knowledge gap.

Goals of the Agreement:

The goal of this Agreement is to create and disseminate a reproducible model for cost-effective locally-available renewable energy resources for electricity while supporting the advancement of renewable energy for transportation and other uses. The project will demonstrate locally-available community-scale solar energy integrated with electric vehicle charging stations and using a highly local, accurate solar forecast to throttle the speed of charge thereby shaving off the peak load on critical days and smoothing load on others. This will also reduce electricity imported from external sources, thereby increasing energy security and reliability.

Objectives of the Agreement:

The objectives of this Agreement are to:

1. Install 100 kW of CPV, achieving a 75%+ performance ratio and 90%+ availability factor
2. Install 12 solar met stations. Met stations will accurately read Direct Normal Irradiance (DNI) measurements to within 4% Root-Mean-Square Error (RMSE), and be capable of transmitting data and cloud image files to Lawrence Livermore National Laboratory (LLNL) every minute.
3. Develop, demonstrate and verify a solar power forecast method for up to an hour ahead that relies on an inexpensive networked array of instruments and public satellite imagery. Increase the temporal and spatial resolution of cloud and aerosol tracking from 1 kilometer (current state of the art) to 1 meter (sky imagers).
4. Develop, demonstrate and verify improvements in building energy power use and demand reduction by implementing an energy use forecast from environmental factors (solar + weather). By predicting future energy needs and solar generation, it is expected to reduce heating, ventilation, and air-conditioning (HVAC) power demands by up to 10%.
5. Document and communicate the lessons and successes from this model to relevant stakeholders including other California communities, regional governments, municipal utilities, research institutions and business groups.

TASK 1 ADMINISTRATION

Instructions for Submitting Electronic Files and Developing Software

Electronic File Format

The Recipient will deliver an electronic copy (CD ROM or memory stick or as otherwise specified by the Commission Project Manager (CPM) of the full text of any Agreement products in a compatible version of Microsoft Word (.doc).

The following describes the accepted formats of electronic data and documents provided to the Energy Commission as products and establishes the computer platforms, operating systems, and software versions that will be required to review and approve all software deliverables.

- Data sets will be in Microsoft (MS) Access or MS Excel file format.

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- PC-based text documents will be in MS Word file format.
- Documents intended for public distribution will be in PDF file format, with the native file format provided as well.
- Project management documents will be in MS Project file format.

Software Application Development

If this Scope of Work includes any software application development, including but not limited to databases, websites, models, or modeling tools, the Recipient will use the following standard Application Architecture components in compatible versions:

- Microsoft ASP.NET framework (version 3.5 and up) Recommend 4.0.
- Microsoft Internet Information Services (IIS), (version 6 and up) Recommend 7.5.
- Team Foundation Server Visual Source Safe 2005 for Development Tool.
- Visual Studio.NET (version 2008 and up) Recommend 2010.
- C# Programming Language with Presentation (UI), Business Object and Data Layers.
- JavaScript, allowed JavaScript Library – JQuery, and AJAX Control Toolkit for Visual Studio for scripting language.
- XHTML transitional for Markup Language.
- Component One for Third Party Software.
- 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 Energy Commission's Information Technology Services Branch. Any third party software not mentioned in the above list must be approved by the Energy Commission's Information Technology Services Branch.

Task 1.1 Attend Kick-off Meeting

The goal of this task is to establish the lines of communication and procedures for implementing this Agreement.

The Recipient shall:

- Attend a "Kick-Off" meeting with the CPM, the Grants Officer, and a representative of the Accounting Office. The Recipient shall bring its Project Manager, Agreement Administrator, Accounting Officer, and others designated by the CPM to this meeting. The administrative and technical aspects of this Agreement will be discussed at the meeting. Prior to the kick-off meeting, the CPM will provide an agenda to all potential meeting participants.

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The administrative portion of the meeting shall include, but not be limited to, the following:

- Discussion of the terms and conditions of the Agreement
- Discussion of Critical Project Review (Task 1.2)
- Match fund documentation (Task 1.6) *No work may be performed until this documentation is in place.*
- Permit documentation (Task 1.7)
- Discussion of subcontracts needed to carry out project (Task 1.8)

The technical portion of the meeting shall include, but not be limited to, the following:

- The CPM's expectations for accomplishing tasks described in the Scope of Work
- An updated Schedule of Products
- Discussion of Progress Reports (Task 1.4)
- Discussion of Technical Products (Product Guidelines located in Section 5 of the Terms and Conditions)
- Discussion of the Final Report (Task 1.5)

The CPM shall designate the date and location of this meeting.

- Submit an updated Schedule of Products, List of Match Funds, and List of Permits to the CPM.

Recipient Products:

- Updated Schedule of Products
- Updated List of Match Funds
- Updated List of Permits

Commission Project Manager Product:

- Kick-Off Meeting Agenda

Task 1.2 Critical Project Review (CPR) Meetings

The goal of this task is to determine if the project should continue to receive Energy Commission funding to complete this Agreement and to identify any needed modifications to the tasks, products, schedule, or budget.

CPRs provide the opportunity for frank discussions between the CPM and the Recipient. The CPM may schedule CPRs as necessary, and CPR costs will be borne by the Recipient.

Participants include the CPM and the Recipient, and may include the Commission Grants Officer, the Energy Research and Development Division technical lead, other

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Energy Commission staff and Management, and any other individuals selected by the CPM to provide support to the Energy Commission.

The Commission Project Manager shall:

- Determine the location, date, and time of each CPR meeting with the Recipient. These 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 Commission Project Manager.
- Send the Recipient the agenda and a list of expected participants in advance of each CPR. If applicable, the agenda shall include a discussion of both match funding and permits.
- Conduct and make a record of each CPR meeting. One of the outcomes of this meeting will be a schedule for providing the written determination described below.
- Determine whether to continue the project, and if so whether modifications are needed to the tasks, schedule, products, and/or budget for the remainder of the Agreement. If the CPM 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 written determination in accordance with the schedule. The written response may include a requirement for the Recipient to revise one or more products that were included in the CPR.

The Recipient shall:

- Prepare a CPR Report for each CPR that discusses the progress of the Agreement toward achieving its goals and objectives. This report shall include recommendations and conclusions regarding continued work on the project. This report shall be submitted along with any other products identified in this Scope of Work. The Recipient shall submit these documents to the CPM and any other designated reviewers at least 15 working days in advance of each CPR meeting.
- Present the required information at each CPR meeting and participate in a discussion about the Agreement.

Commission Project Manager Products:

- Agenda and a list of expected participants
- Schedule for written determination
- Written determination

Recipient Product:

- CPR Report(s)

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Task 1.3 Final Meeting

The goal of this task is to close out this Agreement.

The Recipient shall:

- Meet with Energy Commission staff to present the project findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement.

This meeting will be attended by, at a minimum, the Recipient, the Commission Grants Office Officer, and the CPM. The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be divided into two separate meetings at the discretion of the CPM.

The technical portion of the meeting shall involve the presentation of an assessment of the degree to which project and task goals and objectives were achieved, in addition to findings, conclusions, recommended next steps (if any) for the Agreement, and recommendations for improvements. The CPM will determine the appropriate meeting participants.

The administrative portion of the meeting shall involve a discussion with the CPM and the Grants Officer about the following Agreement closeout items:

- Disposition of any equipment purchased with Energy Commission funds
- Energy Commission's request for specific "generated" data (not already provided in Agreement products)
- Need to document Recipient's disclosure of "subject inventions" developed under the Agreement
- "Surviving" Agreement provisions
- Final invoicing and release of retention
- Prepare written documentation of any agreements made between the Recipient and Commission staff during the meeting.
- Prepare a schedule for completing the closeout activities for this Agreement.

Products:

- Written documentation of meeting agreements
- Schedule for completing closeout activities

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Task 1.4 Monthly Progress Reports

The goal of this task is to periodically verify that satisfactory and continued progress is made towards achieving the research objectives of this Agreement on time and within budget.

The objectives of this task are to summarize activities performed during the reporting period, to identify activities planned for the next reporting period, to identify issues that may affect performance and expenditures, and to form the basis for determining whether invoices are consistent with work performed.

The Recipient shall:

- Prepare a Monthly Progress Report that summarizes all Agreement activities conducted by the Recipient for the reporting period, including an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. Each progress report is due to the CPM within 10 days of the end of the reporting period. The recommended specifications for each progress report are contained in the Terms and Conditions of this Agreement.
- In each Monthly Progress Report and invoice, document and verify:
 - Energy Commission funds received by California-Based Entities (CBEs);
 - Energy Commission funds spent in California; and Match fund expenditures
 - Provide synopsis of project progress.

Product:

- Monthly Progress Reports

Task 1.5 Final Report

The goal of the Final Report is to assess the project's success in achieving its goals and objectives, advancing science and technology, and providing energy-related and other benefits to California.

The objectives of the Final Report are to clearly and completely describe the project's purpose, approach, activities performed, results, and advancements in science and technology; to present a public assessment of the success of the project as measured by the degree to which goals and objectives were achieved; to make insightful observations based on results obtained; to draw conclusions; and to make recommendations for further projects and improvements.

The Final Report shall be a public document. If the Recipient has obtained confidential status from the Energy Commission and will also prepare a confidential version of the Final Report, the Recipient shall perform the following activities for both the public and confidential versions of the Final Report.

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The Recipient shall:

- Prepare an Outline of the Final Report. Prepare a Final Report following the approved outline and the latest version of the Final Report guidelines which will be provided by the CPM. The CPM shall provide written comments on the Draft Final Report within 15 working days of receipt. The Final Report must be completed at least 90 days before the end of the Agreement Term.
- Submit one bound copy of the Final Report with the final invoice.

Products:

- Draft Outline of the Final Report
- Final Outline of the Final Report
- Draft Final Report
- Final Report

Task 1.6 Identify and Obtain Match Funds

The goal of this task is to ensure that the match funds planned for this Agreement are obtained and applied to this Agreement during the term of this Agreement.

The costs to obtain and document match fund commitments are not reimbursable through this Agreement. Although the Energy Commission budget for this task will be zero dollars, the Recipient may utilize match funds for this task. Match funds shall be spent concurrently or in advance of Energy Commission funds for each task during the term of this Agreement. Match funds must be identified in writing and the associated commitments obtained before the Recipient can incur any costs for which the Recipient will request reimbursement.

The Recipient shall:

- Prepare a letter documenting the match funding committed to this Agreement and submit it to the CPM at least 2 working days prior to the kick-off meeting. 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 such 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 each cash match fund, its source (including a contact name, address and telephone number), and the task(s) to which the match funds will be applied.
 - Amount of each in-kind contribution, a description, documented market or book value, its 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

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- Provide a copy of the letter of commitment from an authorized representative of each source of cash match funding or in-kind contributions that these funds or contributions have been secured. For match funds provided by a grant a copy of the executed grant shall be submitted in place of a letter of commitment.
- Discuss match funds and the implications to the Agreement if they are reduced or not obtained as committed, at the kick-off meeting. 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 letter including the appropriate information to the CPM if during the course of the Agreement additional match funds are received.
- Provide a letter to the CPM within 10 days if during the course of the Agreement existing match funds are reduced. Reduction in match funds must be approved through a formal amendment to the Agreement and may trigger an additional CPR.

Products:

- A letter regarding match funds or stating that no match funds are provided
- Copy(ies) of each match fund commitment letter(s) (if applicable)
- Letter(s) for new match funds (if applicable)
- Letter that match funds were reduced (if applicable)

Task 1.7 Identify and Obtain Required Permits

The goal of this task 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. Although the Energy Commission budget for this task will be zero dollars, the Recipient shall budget match funds for any expected expenditures associated with obtaining permits. Permits must be identified in writing and obtained before the Recipient can make any expenditure for which a permit is required.

The Recipient shall:

- Prepare a letter documenting the permits required to conduct this Agreement and submit it to the CPM at least 2 working days prior to the kick-off meeting. If there are no permits required at the start of this Agreement, then state such in the letter. If it is known at the beginning of the Agreement that permits will be required during the course of the Agreement, provide in the letter:

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- A list of the permits that identifies the:
 - Type of permit
 - Name, address and telephone number of the permitting jurisdictions or lead agencies
- The schedule the Recipient will follow in applying for and obtaining these permits.
- Discuss the list of permits and the schedule for obtaining them at the kick-off meeting and develop a timetable for submitting the updated list, schedule, and copies of the permits. The implications to the Agreement 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 the Progress Reports and will be a topic at CPR meetings.
- If during the course of the Agreement additional permits become necessary, provide an updated list of permits (including the appropriate information on each permit) and an updated schedule to the CPM.
- As permits are obtained, send a copy of each approved permit to the CPM.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the CPM within 5 working days. Either of these events may trigger an additional CPR.

Products:

- Letter documenting the permits or stating that no permits are required
- Updated list of permits as they change during the term of the Agreement (if applicable)
- Updated schedule for acquiring permits as changes occur during the term of the Agreement (if applicable)
- A copy of each approved permit (if applicable)

Task 1.8 Obtain and Execute Subcontracts

The goal of this task is to ensure quality products and to procure subcontracts required to carry out the tasks under this Agreement consistent with the terms and conditions of this Agreement and the Recipient's own procurement policies and procedures. This task will also provide the Energy Commission an opportunity to review the subcontracts to ensure that the tasks are consistent with this Agreement, and that the budgeted expenditures are reasonable and consistent with applicable cost principles.

The Recipient shall:

- Manage and coordinate subcontractor activities.
- Submit a draft of each subcontract required to conduct the work under this Agreement to the Commission Agreement Manager for review.
- Submit a final copy of the executed subcontract.
- If the Recipient decides to add new subcontractors, it shall notify the Commission Agreement Manager.

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Products:

- Draft subcontracts
- Final subcontracts

TECHNICAL TASKS

TASK 2 INSTALL AND OPERATE 100 KW OF CPV ARRAYS

TASK 2.1 Order / Manufacture CPV Arrays, Phase I

The goal of this task is to obtain all the equipment and supplies necessary to install the first phase of CPV arrays (approximately 10 kW).

The Recipient shall:

- Determine final Bill of Materials for CPV arrays. Staff will determine what configuration of its system is most optimal for the Livermore Valley Open Campus (LVOC) site, including what type of inverter to use and how to do the wiring for the system
- Order components for Phase I. All components are expected to be manufactured using existing contract manufacturers. Copies of Purchase Orders submitted to vendors will be sent to the Energy Commission for review
- Receive and inspect components for Phase I System. Copies of Invoices from manufacturers will be sent to the Energy Commission
- Prepare and provide a Phase I CPV Manufacture Report that includes, but is not limited to:
 - A discussion of CPV system configuration, including inverter type and wiring for the system
 - Copies of Purchase Orders submitted to major sub-system vendors
 - Copies of Invoices from major sub-system manufacturers
 - Images of equipment upon arrival and after inspection

Products:

- Phase I CPV Manufacture Report (No Draft)

TASK 2.2 Prepare LVOC Site for Construction and Installation of CPV Arrays

The goal of this task is to prepare the LVOC site for the construction and installation of Recipient's CPV array.

The Recipient shall:

- Prepare and provide a Draft Site Preparation Plan Checklist. This will include all activities that must be completed to prepare site for the installation of the CPV arrays
- Finalize site plan drawings for construction. Drawings will include electrical layout diagram, physical layout of solar equipment, inverters, any buildings on site, etc. Send these drawing to the Energy Commission

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- Confirm station service power present. Station service power appears to already be present at the site. If not, any electrical work necessary to prepare an electrical connection for all equipment at the site will be performed
- Grade the site if necessary and install a fence around it
- Confirm the construction lay-down area is ready and construction management buildings are installed and operational. A mobile modular unit will be installed at the site to serve as the headquarters for scientists and workers present at the site
- Install monitoring equipment. This will include the central server that communicates with all the arrays – the Supervisory Control And Data Acquisition (SCADA) system
- Complete Final Site Preparation Plan Checklist and submit to the Energy Commission when all items have been completed along with digital images taken of the site at the completion of preparation work

Products:

- Draft Site Preparation Plan Checklist
- Final Site Preparation Plan Checklist
- Final Site Plan Drawings (No Draft)

TASK 2.3 Install and Operate Phase I of CPV Arrays

The goal of this task is to install the first phase – approximately 10 kW – of Recipient’s CPV modules and trackers at the Livermore Valley Open Campus. Operational and performance data will be collected and used to make small improvements to the second phase of the installation.

The Recipient shall:

- Assemble and install rigs for Phase I
- Prepare a Phase I Rig Installation and Production Confirmation Memo for the Energy Commission confirming all rigs have been installed and are producing power
- Collect and analyze installation data for Phase I. Recipient will log the labor time for installing these rigs. Metrics on time and labor for the installation will provide guidance in modeling future projects accurately. It will also prepare a presentation on methods to reduce installation time and effort on Phase II and other future projects
- Collect and analyze performance data for Phase I. This will include measurements of cell temperature, module efficiency, string efficiency, system efficiency, up-time, I-V curves, total power output, performance ratio, etc.
- Collect and analyze operations data for Phase I. Recipient will monitor and record: i) the actual film life vs. the expected 3 years, ii) the actual film change out labor vs. our laboratory demonstrated 20 min., and iii) our in-field cleaning procedures vs. the expected 3-week intervals in the summer. In addition, Recipient will gather in-field service data on the various components of the rig. This activity addresses bankability of the technology and is critical to bringing the system to commercial market readiness
- Prepare and provide a Phase I Initial Performance Results Report for the Energy Commission that includes, but is not limited to measurements of heat sink temperature, module efficiency, system efficiency, up-time, I-V curves, and total power output
- Operate, monitor, and maintain the system. Staff will ensure the system remains operational and that maintenance tasks, such as cleaning the films, are performed as needed. A log of all maintenance work will be kept to help inform operations and maintenance (O&M) cost and time estimates

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- Prepare and provide a Phase I Analysis and Suggested Improvement Presentation for the Energy Commission that includes, but is not limited to, an analysis of the Phase I performance results and suggested improvements for Phase II
- Participate in CPR per Task 1.2

Products:

- Phase I Rig Installation and Production Confirmation Memo (No Draft)
- Phase I Initial Performance Results Report (No Draft)
- Phase I Analysis and Suggested Improvement Presentation (No Draft)
- CPR Report per Task 1.2

TASK 2.4 Order / Manufacture CPV Arrays, Phase II

The goals of this task are to:

1. Make small improvements to the system design, and
2. Obtain all the equipment and supplies necessary to install the second phase of Recipient's CPV arrays (approximately 100 kW or 24 rigs)

The Recipient shall:

- Adjust system design as needed. From experience gained during the installation and operation of Phase I, engineers may find components of the system that can be re-designed to increase efficiency and output, reduce installation time, and/or improve reliability. Engineers will go through design reviews with their peers and supervisors to determine the final design for each component. This process will include 1) identifying components for improvement, 2) a lead engineer re-designing the component, 3) the proposed change(s) being reviewed by a supervisor and peers, 4) the proposed change(s) being accepted or sent back for further re-design, and 5) final design completed, reviewed, and approved
- Determine final Bill of Materials for CPV arrays. Recipient staff will incorporate all design changes made and determine the final list of components to be used for Phase II of the installation at the LVOC site
- Order components for Phase II. Copies of Purchase Orders submitted to vendors will be sent to the Energy Commission for review
- Receive and inspect components for Phase II. Copies of Invoices from manufacturers will be sent to the Energy Commission along with images showing the equipment either at the project site or at Recipient's warehouse in Livermore following inspection
- Prepare and provide a Phase II CPV Manufacture Report that includes, at a minimum:
 - A discussion of design changes and improvements from Phase I
 - A list of components that will be modified from the original design
 - A brief summary of what each improvement is, why it is being made, and what the expected improvement will be (e.g. x % greater optical efficiency, x months longer life, x minutes per component faster to install, x dollars cheaper to manufacture, x lbs less material, x fewer process steps in assembly, etc.)
 - Copies of Purchase Orders submitted to major sub-system vendors
 - Copies of Invoices from major sub-system manufacturers
 - Images of major sub-system equipment upon arrival and after inspection

Products:

Exhibit A WORK STATEMENT

- Phase II CPV Manufacture Report (No Draft)

TASK 2.5 Install and Operate Phase II of CPV Arrays

The goal of this task is to install the second phase – approximately 90 kW – of Recipient's CPV modules and trackers at the Livermore Valley Open Campus. System will achieve a performance ratio greater than 75% and an availability factor of at least 95%.

The Recipient shall:

- Assemble and install rigs for Phase II
- Prepare and provide a Phase II Rig Installation and Production Confirmation Memo for the Energy Commission confirming all rigs have been installed and are producing power
- Collect and analyze installation data for Phase II. Recipient will log the labor time for installing these rigs. Metrics on time and labor for the installation will provide guidance in modeling future projects accurately
- Prepare and provide a Phase II Analysis and Suggested Improvement Presentation Report that includes methods to reduce installation time and efforts on future projects
- Collect and analyze performance data for Phase II. This will include measurements of cell temperature, module efficiency, string efficiency, system efficiency, up-time, I-V curves, total power output, performance ratio, etc. Some measurements such as cell temperature and string efficiency will be collected from a designated reference rig. A draft report of these performance results will be sent to the Energy Commission
- Collect and analyze operations data for Phase II. Recipient will monitor and record: i) the actual film life vs. the expected 3 years, ii) the actual film change out labor vs. our laboratory demonstrated 20 min., and iii) our in-field cleaning procedures vs. the expected 3-week intervals in the summer. In addition, Recipient will gather in-field service data on the various components of the rig. This activity addresses bankability of the technology and is critical to bringing the system to commercial market readiness
- Operate, monitor, and maintain the system. Staff will ensure the system remains operational and that maintenance tasks, such as cleaning the films, are performed as needed. A log of all maintenance work will be kept to help inform O&M cost and time estimates
- Complete and provide a Draft and Final CPV System Installation, Performance and Operations Results Report. The report will provide information on the weather conditions present at the site on an hourly basis, including the available solar resource at the plane of array and analyze total system output and identify all the loss mechanisms (e.g. cell efficiency, tracking, shading, wiring, inverter(s), etc.). It will also detail inverter up-time, tracking system up-time, and include the O&M log. The draft will be reviewed internally and by the Energy Commission Agreement Manager and a Final Report will then be submitted to the Energy Commission

Products:

- Phase II Rig Installation and Production Confirmation Memo (No Draft)
- Phase II Analysis and Suggested Improvement Presentation (No Draft)
- Draft CPV System Installation, Performance and Operations Results Report
- Final CPV System Installation, Performance and Operations Results Report

Exhibit A WORK STATEMENT

TASK 3 DEPLOY NETWORKED ARRAY OF SKY IMAGERS

TASK 3.1 Prepare Sites for Installation of Met Stations

The goal of this task is to geographically deploy up to 12 networked met stations to be used as sky imagers for the solar forecast model development.

The Recipient shall:

- Work with key partners to finalize agreements for the installation of solar met stations at existing weather monitoring stations. The National Weather Service's San Francisco Bay Area Weather Forecast Office, for example, has a network of around 100 weather sites in the region. Alternately, the Recipient has spoken with PG&E in the past about using PG&E substations or other properties to host these stations and could revisit this conversation. A total of twelve sites are expected to be needed
- Prepare these sites for the installation of the met stations. This will include confirming the view of the sky from the installation point is relatively clear, open ground space is available, grid connection for back-up power is present, and telecommunications capabilities are in place (either an Ethernet port or a strong cellular network signal)
- Prepare and provide a Met Station Site Preparation Memo that includes, but is not limited to:
 - A listing of met station site locations
 - A discussion of why each site location was chosen
 - Copies of host site agreements

Products:

- Met Station Site Preparation Memo (No Draft)

TASK 3.2 Assemble and Test 14 Met stations

The goal of this task is to produce 14 operation-ready met stations. Twelve of these units will be deployed and two units will be kept as spares for rapid replacement of any units that may fail during the course of the Agreement.

The Recipient shall:

- Determine the final Bill of Materials for the 14 met stations
- Order components
- Receive and inspect components
- Integrate and assemble components for the 14 met stations
- Prepare a Met Station Inspection Checklist Template that will be provided to the Energy Commission prior to arrival of the devices
- Test all met stations operate correctly against inspection checklist
- Prepare and provide a Met Station Test and Assembly Report that includes, but is not limited to:

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- A discussion of assembly and testing of met stations
- Completed inspection checklists for the 14 met stations
- Copies of Purchase Orders for all critical subcomponents ordered
- Copies of Invoices from critical subcomponents vendors when equipment is received

Products:

- Met Station Inspection Checklist Template (No Draft)
- Met Station Test and Assembly Report (No Draft)

TASK 3.3 Install and Operate Met Stations

The goal of this task is to install the met stations and prove they are comparable in performance to currently available solar met stations. Activities in this task will also determine how effective the met stations are at providing accurate measurements even when soiled.

The Recipient shall:

- Install the met stations at each of the 12 designated locations and connect them to the network. One of these locations will be at the LVOC site. A high quality met station with first class pyranometers will also be installed there by Sandia and used to determine the accuracy of the solar resource data from met station
- Validate data network and data repository for streaming image data. The exact communication mechanism has not yet been determined and will depend on what is available at the site. The most likely options are either an Ethernet connection or via a cellular network. The goal is for each met station to be able to send images and data to LLNL at least every minute
- Test performance of met station in measuring the solar resource (DNI) against the high quality met station installed at the LVOC site by Sandia. Goal is to be within at least 4% RMSE of the high quality met station measurements
- Maintain instrument and network operational status during deployment. This includes performing regular maintenance of the met stations and on an as needed basis. The mirrors are expected to need cleaning monthly initially and quarterly by the final three months
- Prepare and provide a Draft and Final Met Station Installation and Operation Report that includes, but is not limited to:
 - A comparison of solar irradiance measurement accuracy of the two stations installed at the LVOC,
 - A discussion of the communication mechanism used for data network and repository for streaming met station image data,
 - Images of the met stations at their installed locations and representative data samples received by LLNL,
 - An analysis of how much variation in the accuracy of the measurement of the solar resource was due to a dirty lens, and
 - Discussion of the maintenance and cleaning schedule and device's ability to adjust for soiling

Products:

- Draft Met Station Installation and Operation Report
- Final Met Station Installation and Operation Report

Exhibit A WORK STATEMENT

TASK 4 DEVELOP, TEST, AND DEMONSTRATE SOLAR POWER FORECAST MODEL

TASK 4.1 Develop PV Power Model of CPV Installation

The goal of this task is to develop a functional model of the installed array of CPV solar collectors that relates solar input to power output.

The Recipient shall:

- Specify the type and number of solar collectors
- Specify the performance characteristics of each solar collector
- Develop a photon input/electron output model of the collectors
- Prepare and provide a Power Model Characteristics Report that includes, but is not limited to:
 - A discussion of the functional CPV array model developed,
 - The type and number of solar collectors, and
 - The performance characteristics of each solar collector

Products:

- Power Model Characteristics Report (No Draft)

TASK 4.2 Develop Solar Forecast Engine with Imager and Satellite Data Input

The goal of this task is to develop an hour-ahead functional solar power forecasting engine in software based on real-time observational data from sky imagers and satellite images.

The Recipient shall:

- Develop data interface to Recipient sky imagers
- Develop data interface to GOES-WEST satellite data
- Define test and validation constraints
- Develop solar (photon) input forecast algorithm using both imager and satellite data
- Develop power (electron) output forecast from solar (photon) input forecast combined with PV device model
- Instantiate forecast algorithm in software
- Prepare and provide a Draft and Final Forecast Engine Features and Design Report that includes, but is not limited to, a discussion of each of the above items addressed in this task
- Provide Data Archive from Forecast Engine Software to the Energy Commission

Products:

- Draft Forecast Engine Features and Design Report
- Final Forecast Engine Features and Design Report
- Data Archive from Forecast Engine Software (No Draft)

TASK 4.3 Validate Power Forecasts with CPV Installation Collector Data

The goal of this task is to validate the performance and accuracy of the forecast engine using PV SCADA data from the CPV installation.

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The Recipient shall:

- Instrument the CPV collectors to provide continuous SCADA data of individual and collective panel temperatures, panel voltages, panel currents
- Prepare and provide a Test Site Instrumentation Memo that summarizes the instrumentation activity listed in the above bullet.
- Install one solar met station at the test site and operate continuously
- Acquire and archive all SCADA and met data from the test site
- Prepare and provide Forecast Input and Output Data Archive to the Energy Commission
- Identify operational periods to be used for validation
- Validate forecast performance with actual PV performance during selected periods
- Evaluate magnitude and sources of error
- Prepare and provide a Draft and Final Validation Test Results and Error Analysis Report that includes, but is not limited to:
 - A description of the efforts undertaken in this task
 - A discussion of forecast input and output data
 - Operational periods used for validation
 - Forecast engine performance
 - Magnitude and sources of error

Products:

- Test Site Instrumentation Memo (No Draft)
- Forecast Input and Output Data Archive (No Draft)
- Draft Validation Test Results and Error Analysis Report
- Final Validation Test Results and Error Analysis Report

TASK 5 OPTIMIZE BUILDING ENERGY MANAGEMENT USING ENVIRONMENTAL FORECASTS

TASK 5.1 Develop Predictive Building Energy Use Model

The goal of this task is to quantify the effects of transient environmental (solar & wind) loads on building energy use. The project team will incorporate this analysis into a dynamic model that predicts the building energy use for any specified environmental transient load.

The Recipient shall:

- Analyze wind and solar environmental loads on building thermal response using existing American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) procedures
- Create a dynamic model of Sandia building 690 HVAC energy use from environmental loads
- Validate model results with building and met SCADA data
- Prepare and provide a Draft and Final Building Energy Use Model and Validation Test Report that includes, but is not limited to a discussion of each of the activities identified in this task

Products:

- Draft Building Energy Use Model and Validation Test Report
- Final Building Energy Use Model and Validation Test Report

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TASK 5.2 Develop Forecast of Environmental Building Energy Loads

The goal of this task is to forecast the environmental thermal loads needed for building energy management.

The Recipient shall:

- Combine the solar insolation forecast of Task 4 with public domain wind forecasts from the National Center for Atmospheric Research (NCAR)
- Convert atmospheric forecasts into building energy boundary conditions
- Couple the forecasts to the building energy use model
- Prepare an Environmental Forecast Methodology Report that includes, but is not limited to a discussion of each of the activities identified in this task

Products:

- Environmental Forecast Methodology Report (No Draft)

TASK 5.3 Demonstrate Building Energy Reduction Using Environmental Forecasts

The goal of this task is to demonstrate the building energy efficiency improvements that can be obtained by optimizing HVAC control using environmental forecasts.

The Recipient shall:

- Determine best-case (ideal) efficiency gains from using forecasts in building energy management
- Demonstrate efficiency gains using the transient building model with environmental forecasts
- Validate efficiency gains with test data at Sandia building 690
- Prepare and provide a Draft and Final Building Energy Reduction Using Environmental Forecasts Demonstration Report that includes, but is not limited to:
 - A discussion of each of the activities identified in this task
 - A quantified reduction in annual building energy use achieved by the proposed forecasting methodology for HVAC control

Products:

- Draft Building Energy Reduction Using Environmental Forecasts Demonstration Report
- Final Building Energy Reduction Using Environmental Forecasts Demonstration Report

TASK 6 OUTREACH

The goal of this task is to document the lessons learned and successes from this model community project and communicate them widely to relevant stakeholders from California communities and utilities, to research institutions and local business groups. Communication will be through multiple mediums: reports, presentations, site tours, and possibly webinars.

The Recipient shall:

- Prepare and provide a Draft and Final Potential Adopter Outreach Slide Presentation to document the lessons learned and successes from this project in a short report geared

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towards potential model adopters: cities, commercial parks, utilities, research institutions, and local business groups.

- Prepare and provide a Potential Adopter Outreach Report to complement and expand upon the content of the Final Potential Adopter Outreach Slide Presentation
- Disseminate the report to these groups through multiple mediums: announcements with links to download the report to listserves, site tours, presentations, and webinars. Examples of targeted groups include: i-Gate/i-Hub, the Livermore Valley Open Campus Community Advisory Council, The East Bay Green Corridor (includes 9 members cities and 4 research institutions), San Diego Gas & Electric, Sacramento Municipal Utility District, UC Berkeley, Berkeley Energy & Resources Collaborative Energy Symposium, Stanford University, etc.
- Provide Outreach Event Attendee Lists from at least three presentations, site tours, or webinars

Products:

- Draft Potential Adopter Outreach Slide Presentation
- Final Potential Adopter Outreach Slide Presentation
- Potential Adopter Outreach Report (No Draft)
- Outreach Event Attendee Lists (No Draft)

TASK 7 TECHNOLOGY TRANSFER ACTIVITIES

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

The Recipient shall:

- Prepare and provide a Draft and Final Technology Transfer Plan that explains how the knowledge gained in this project will be made available to the public. The level of detail expected is least for research-related projects and highest for demonstration projects. Key elements from this report shall be included in the Final Report for this project
- Conduct technology transfer activities in accordance with the Technology Transfer Plan. These activities will be reported in the Monthly Progress Reports
- Indicate the intended use(s) and users of the project results

Products:

- Draft Technology Transfer Plan
- Final Technology Transfer Plan

TASK 8 PRODUCTION READINESS PLAN

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

The Recipient shall:

- Prepare and provide a Draft and Final Production Readiness Plan. The degree of detail in the plan should be proportional to the complexity of producing or commercializing the proposed product and its state of development. As appropriate, the plan will include but not be limited to a discussion of the

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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”
- A projected “should cost” for the product when in production
- The expected investment threshold to launch the commercial product
- An implementation plan to ramp up to full production

Products:

- Draft Production Readiness Plan
- Final Production Readiness Plan



Award Number: PIR-12-016

Date: 2 / 26 / 2013

Note: The Energy Commission Project Managers Manual includes detailed instructions on how to complete this section, with examples of grants that are “Projects” and are not “Projects”. When the Project Manager is completing this section, if questions arise as to the appropriate answers to the questions below, please consult with the Energy Commission attorney assigned to review grants or loans for your division.

1. Is grant/loan considered a “Project” under CEQA? Yes (skip to question #2) No (continue with question #1)

Please complete the following: [Public Resources Code (PRC) 21065 and 14 California Code of Regulations (CCR) 15378]:

Explain why the grant/loan is **not** considered a “Project”? The grant/loan will not cause a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment because grant/loan involves:

2. If grant/loan is considered a “Project” under CEQA: (choose either **IS** or **IS NOT**)

Grant/loan **IS** exempt:

Statutory Exemption: (List PRC and/or CCR section numbers) _____

Categorical Exemption: (List CCR section number) 14 CCR 15303

Common Sense Exemption. (14 CCR 15061(b)(3))

Explain reason why the grant/loan is exempt under the above section:

New construction of limited small new facilities; installation of small, new equipment and facilities in small structures; and conversion of the use of small existing structures (e.g., construction of three or fewer single-family homes in urban areas)

Please attach draft Notice of Exemption (NOE). Consult with the Energy Commission attorney assigned to your division for instructions on how to complete the NOE.

Grant/loan **IS NOT** exempt. The Project Manager needs to consult with the Energy Commission attorney assigned to your division and the Siting Office regarding a possible initial study.