

GRANT REQUEST FORM (GRF)New Agreement EPC-14-079 (To be completed by CGL Office)

Division	Agreement Manager:	MS-	Phone
ERDD	Hassan Mohammed	43	916-327-1442

Recipient's Legal Name	Federal ID Number
Electric Power Research Institute, Inc.	23-7175375

Title of Project
Assessing the Ability of Smart Inverters and Smart Consumer Devices to Enable More Residential Solar Energy

Term and Amount	Start Date	End Date	Amount
	6/30/2015	3/29/2019	\$ 1,705,478

Business Meeting Information
 ARFVTP agreements under \$75K delegated to Executive Director.

Proposed Business Meeting Date	5/27/2015	<input type="checkbox"/> Consent	<input checked="" type="checkbox"/> Discussion
Business Meeting Presenter	Hassan Mohammed	Time Needed:	5 minutes

Please select one list serve. Select

Agenda Item Subject and Description

ELECTRIC POWER RESEARCH INSTITUTE. Proposed resolution approving agreement EPC-14-079 with Electric Power Research Institute (EPRI) for a \$1,705,478 grant to resolve the limiting conditions that occur on California distribution systems when many PV systems are installed behind a single residential distribution transformer by evaluating advanced inverter functionality with specific goal of enabling higher penetration of photovoltaic on the grid. The project will identify, implement, and test optimal methods by which smart inverters can mitigate the issues that otherwise would limit local high penetrations of residential PV.

California Environmental Quality Act (CEQA) Compliance

- 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
- 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: Cal. Code Regs., tit. 14, §§ 15301, 15303 & 15306
 - Common Sense Exemption. 14 CCR 15061 (b) (3)

Explain reason why Agreement is exempt under the above section:

Cal. Code Regs., tit. 14, sect. 14 CCR 15301: The proposed project will replace old solar inverters on existing residential dwellings with new smart inverters. The inverters to be installed on existing homes are approximately 17.10W x 11.60H x 8.40D inches and a weight of 71 lbs. Associated wiring will also be installed to connect the smart inverters to the solar PV array DC disconnect box from one side and to the AC disconnect box on the other side. All these connections will be outside of the residential dwelling and no trenching or underground wiring will occur. Installing inverters boxes and their associated wiring on the exterior of homes will not significantly expand the use beyond that already existing and will result in no significant environmental impact. For these reasons, the project falls within section 15301.

Cal. Code Regs., tit. 14, sect. 14 CCR 15303: The proposed project consists of the delivery and installation of new smart inverters, which are small new equipment, as described above, at residential dwellings, and will not have a significant effect on the environment. For this reason, the proposed project falls within section 15303.

Cal. Code Regs., tit. 14, sect. 14 CCR 15306: The proposed project will conduct laboratory testing, consisting of testing grid simulation equipment and smart inverter functions and settings, at an existing laboratory; computer modeling and algorithm development; and field testing via installation of smart inverters at residential dwellings, as described above, and the collection of smart inverter performance data from those residences. The information gathered from laboratory and field testing will have no significant impact on the environment. For these reasons, the proposed project falls under section 15306.
 - b) Agreement **IS NOT** exempt. (Consult with the legal office to determine next steps.)

Check all that apply

GRANT REQUEST FORM (GRF)



- | | |
|---|---|
| <input type="checkbox"/> Initial Study | <input type="checkbox"/> Environmental Impact Report |
| <input type="checkbox"/> Negative Declaration | <input type="checkbox"/> Statement of Overriding Considerations |
| <input type="checkbox"/> Mitigated Negative Declaration | |

List all subcontractors (major and minor) and equipment vendors: (attach additional sheets as necessary)	
Legal Company Name:	Budget
Pacific Gas and Electric Company	\$ 434,564
Intwine Connect	\$ 298,000
ClipperCreek, INC.	\$ 87,300
Underwriters Laboratories, Inc.	\$ 85,000
	\$
	\$
	\$
	\$
	\$

Exhibit A Scope of Work

A. Task List

Task #	CPR ¹	Task Name
1		General Project Tasks
2		Requirements Development And Acquisition of Equipment
3		Laboratory Test Plan and Preparation
4		Modeling and Algorithm Development
5	X	Laboratory Testing
6		Field Test Site Identification, Preparation and Product Installation
7		Communication and Control System Development
8		Field Test Plan and Test Execution
9		Evaluation of Project Benefits
10		Technology/Knowledge Transfer Activities

B. Acronym/Term List

Acronym/Term	Meaning
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CPR	Critical Project Review
DER	Distributed Energy Resources (e.g. solar plants, electric vehicle chargers, advanced loads)
DR	Demand Response (load devices responding to control signals received)
EVSE	Electric Vehicle Service Equipment (EV chargers)
IOU	Investor Owned Utility
PG&E ATS	PG&E Applied Technology Services
PV	Photovoltaic (solar)
Recipient	Electric Power Research Institute (EPRI)
TAC	Technical Advisory Committee

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.

Exhibit A

Scope of Work

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

A. Purpose of Agreement

The purpose of this Agreement is to evaluate advanced inverter functionality with the goal of enabling higher penetration levels of photovoltaic systems on the California distribution systems. The project is specifically focused on the local PV hosting limitations that occur when multiple PV systems are installed on the same residential transformer. To mitigate these limitations, the project will involve multiple smart inverters and other residential Distributed Energy Resources (DER), e.g., electric vehicle chargers and other smart loads. Over the course of the project, these devices will be enhanced to optimize PV support and tested individually and in combination, in both laboratory and field environments. The process will identify how the functions identified in California Public Utilities Commission's Rule 21 on interconnections ("Rule 21")² can be used and configured so that multiple smart inverters work in harmony (supporting one another's actions) and will also identify how other common consumer devices, such as electric vehicle chargers and other smart loads, can serve to further enable high levels of solar PV.

B. Problem/ Solution Statement

Problem

One of the most prominent factors limiting high penetration of residential solar generation in California distribution systems is when multiple PV systems are installed behind a single distribution transformer. In these cases, the total solar penetration on the feeder may be fine, and the voltage profile along the feeder may be fine, but local over-voltage; variability; and equipment stress occurs on the customer side, limiting PV deployments and production.

Although this is a first-order limiting factor, utility-led research thus far has been focused on the issues that occur at the level of the whole feeder, when aggregate PV is too high. The prior research has primarily looked at what might be possible with added resources like fixed battery storage, without thoroughly investigating what might be accomplished by taking maximum advantage of smart inverter functions; electric vehicles; and other common consumer devices.

Solution

This project will identify, implement, and test (both in lab and field) optimal methods by which smart inverters can mitigate the issues that otherwise would limit local high penetrations of residential PV. This project will identify how Rule 21 functions can be used and configured so that multiple smart inverters work in harmony (supporting one another's actions). This project will also identify how other common consumer devices, such as electric vehicle chargers and other smart loads, can serve to further enable high penetration levels of residential solar PV into the distribution system.

²Electric Rule 21 describes the interconnection, operating and metering requirements for generation facilities to be connected to a utility's distribution system, over which the California Public Utilities Commission (CPUC) has jurisdiction. Additional Information: http://www.energy.ca.gov/electricity_analysis/rule21/index.html

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C. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

- Evaluate the extent to which Rule 21 smart inverter functions (IEC 61850-90-7 based functions called out in Rule 21) can increase total PV hosting capacity on individual residential transformers.
- Evaluate the extent to which other Distributed Energy Resources (DER), including electric vehicle chargers and other smart consumer devices, can (or cannot) further increase PV hosting capacity.
- Set forth the specific algorithms and methods required to achieve the indicated increases in PV production.

Ratepayer Benefits:³ This Agreement will result in the ratepayer benefits of lower costs by enabling the interconnection of a greater number of PV systems providing more opportunity to own and operate PV and by minimizing any curtailments of these systems that might otherwise be required. This Agreement will also benefit ratepayers by increasing electricity reliability: by identifying methods that might be used to level and reduce stress on local distribution system assets.

Technological Advancement and Breakthroughs:⁴ This Agreement will lead to technological advancement and breakthroughs to overcome barriers to the achievement of the State of California's statutory energy goals by evaluating multiple consumer-scale PV systems performing Rule 21 functionality side-by-side. The project will discover any instabilities or oscillatory conditions that might be inherent when multiple inverters attempt to provide the Rule 21 functions in close proximity to one another. The leading team of utilities, manufacturers, and test laboratories will determine if, and if so, how control loops inside the end-use equipment and the control systems that knit the equipment together must function in order to work supportively together.

The project will also identify how open standard functions, communication systems, and protocols can be applied to achieve the improvements indicated in the previous sections. The project team will be familiar with relevant standards activities (e.g. IEC 61850, IEEE 1547, SunSpec, CEA-2045).

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

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

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Agreement Objectives

The objectives of this Agreement are to:

- Identify the key factors that limit the local PV hosting capacity behind residential transformers.
- Determine which Rule 21 functions can be used to mitigate these limitations, and how each function is to be configured in order to interoperate in a supportive way.
- Quantify the degree to which the local hosting capacity can be increased by using the smart inverter functions.
- Determine the optimal way for other DER to be utilized to further improve the local hosting capacity, including best PV-supporting uses of: EV chargers, thermostats, water heaters, and pool pumps.
- Quantify the additional increase in PV hosting capacity that is possible through the use of other common consumer devices.
- Inform the discussion regarding fixed battery storage by clearly identifying the limits of what is possible using PV inverters and key consumer loads.
- Inform PV-related standards organizations regarding gaps that would result in unstable or conflicting interactions between devices.

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.

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- 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).

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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*)

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- Updated List of Permits (*if applicable*)

CAM Product:

- Kick-off Meeting Agenda

Subtask 1.3 Critical Project Review (CPR) Meetings

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

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

The Recipient shall:

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

The CAM shall:

- Determine the location, date, and time of each CPR meeting with the Recipient's input.
- Send the Recipient a *CPR Agenda* and a *List of Expected CPR Participants* in advance of the CPR meeting. If applicable, the agenda will include a discussion of match funding and permits.
- Conduct and make a record of each CPR meeting. Provide the Recipient with a *Schedule for Providing a Progress Determination* on continuation of the project.
- Determine whether to continue the project, and if so whether modifications are needed to the tasks, schedule, products, or budget for the remainder of the Agreement. If the CAM concludes that satisfactory progress is not being made, this conclusion will be referred to the Deputy Director of the Energy Research and Development Division.
- Provide the Recipient with a *Progress Determination* on continuation of the project, in accordance with the schedule. The Progress Determination may include a requirement that the Recipient revise one or more products.

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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

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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)

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CAM Product:

- Style Manual
- Comments on Draft Final Report Outline
- Approval of Final Report Outline

Subtask 1.6.2 Final Report

The Recipient shall:

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

Products:

- Final Report (draft and final)

MATCH FUNDS, PERMITS, AND SUBCONTRACTS

Subtask 1.7 Match Funds

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

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

The Recipient shall:

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

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- 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*.

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- 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.

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- Evaluate the tangible benefits of the project to the state of California, and provide recommendations as needed to enhance the benefits.
- Provide recommendations regarding information dissemination, market pathways, or commercialization strategies relevant to the project products.

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

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

The Recipient shall:

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

Products:

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

Subtask 1.11 TAC Meetings

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

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.

Exhibit A Scope of Work

- Organize and lead TAC meetings in accordance with the TAC Meeting Schedule. Changes to the schedule must be pre-approved in writing by the CAM.
- Prepare *TAC Meeting Summaries* that include any recommended resolutions of major TAC issues.

Products:

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

Exhibit A

Scope of Work

III. TECHNICAL TASKS

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 Requirements Development And Acquisition of Equipment

The goals of this task are to determine what devices and equipment will be needed for the project, and the requirements for each device and each piece of equipment; and to produce/acquire the equipment.

The Recipient shall:

- Produce a *Smart Inverter Requirements* specification which includes, but is not limited to:
 - Rule 21 functions that must be supported but not configurable (fixed functions)
 - Rule 21 functions that must be supported and configurable
 - The range of adjustability required for each adjustable function
 - The open standard communication interface and protocol that must be supported
- Produce an *EV Charger Functional Specification for PV Support* document that details the functional and communication interface requirements that electric vehicle service equipment (EVSE) must support to be used in the testing required in Tasks 5 & 8.
- Produce a *Consumer Devices Functional Specification for PV Support* document that details the functional and communication interface requirements that thermostats, water heaters, and pool pumps must support to be used in the testing of Tasks 5 and 8.
- Implement the required functionality and interfaces in the solar inverters, EVSEs and other supporting devices. This step includes any hardware and/or firmware changes that manufacturers need to make to their products.
- Produce a *Communication/Control Hub Requirements* document that details the cross-cutting algorithms that will be needed to support the Testing in Tasks 5 and 8.
- Show receipts validating the shipping of the equipment to the laboratory test site in California for testing.

Products:

- *Receipts* showing equipment delivered
- *Smart Inverter Requirements*
- *EV Charger Functional Specification for PV Support*
- *Consumer Devices Functional Specification for PV Support*
- *Communication/Control Hub Requirements*

Exhibit A

Scope of Work

TASK 3 Laboratory Test Plan and Preparation

The goal of this task is to determine the specific steps by which the laboratory testing of Task 5 will be carried out and to setup the necessary facilities and test equipment to support lab testing.

The Recipient shall:

- Produce a *Laboratory Test Plan* that sets forth the step-by-step procedures that will be used in the laboratory. This test plan will include the sequence of test voltages and frequencies of grid simulation equipment, the sequence of smart inverter functions and settings, and the number and type of inverters and other devices involved in each test step. It will also identify the parameters that will be monitored, the data to be captured, and the analysis that will be used to evaluate the results. The purpose of the laboratory testing is to determine how the products behave in a controlled environment, prior to field installation.
- Procure necessary test equipment, wiring, hardware, and test/modeling software needed to carry out the testing.
- Construct the laboratory setup, including the grid connection, the distribution transformer, the three-home environments side by side, the PV systems and PV panel simulators, end devices and test instrumentation.

Products:

- Laboratory Test Plan

TASK 4 Modeling and Algorithm Development

The goal of this task is to determine the optimal way in which each inverter and other DER will function during each test scenario. The Recipient may consult with industry members to determine the optimal way in which the product types involved in this project can help enable more PV. It will also include computer modeling of the Rule 21 smart inverters and other smart devices and simulations to determine the algorithms that will be used to orchestrate the coordinated behavior to the multiple inverters, EVSEs and other smart devices.

The Recipient shall:

- Produce a *PV Support Algorithms* document that identifies how the smart inverters and other DER will be monitored and managed during the execution of each test scenario developed during Task 3.

Products:

- *PV Support Algorithms Document*

TASK 5 Laboratory Testing

The goal of this task is to carry out the laboratory testing utilizing the laboratory prepared in Task 3, the equipment developed in Task 3, and the algorithms identified from Task 4.

The Recipient shall:

- Execute the test plan from Task 3, sequencing through:
 - Multiple inverter brands and assessing the performance of each.
 - Multiple smart inverter function uses and settings.
 - Multiple combinations of smart inverters, with and without other DER.

Exhibit A Scope of Work

- Produce a *Laboratory Test Results* document, summarizing the data and results from the testing and establishing the overall approach to be used in the field testing of Task 8.
- Participate in a CPR meeting and prepare a CPR Report consistent with Task 1.3

Products:

- *Laboratory Test Results Document*
- CPR Report

TASK 6 Field Test Site Identification, Preparation and Product Installation

The goal of this task is to setup the field test sites so that the approaches identified during the laboratory testing of Task 5 can be carried out in actual field scenarios. An estimation of 15-20 homes in both SMUD and SCE territories will be field test sites. This requires that the homes involved include the proper penetration levels of PV systems, ability to upgrade/replace existing inverters with the smart inverters, and the proper mix of other DER which are not always present, such as electric vehicles and pool pumps.

The Recipient shall:

- Identify the test sites to be used (selection methods to be determined during the project)
- Secure permission to access property and conduct work under this project.
- Install the end device equipment identified in Task 2.
- Produce a *Field Test Site Description* document that identifies the exact location and layout of the distribution circuit, utility equipment, homes to be involved, and equipment behind the transformer at each home.

Products:

- *Field Test Site Description Document*

TASK 7 Communication and Control System Development

The goal of this task is to make it possible to carry out the field testing by monitoring and managing (e.g. controlling to carry out the Rule 21 functions) all devices in the residential homes. This project involves a set of homes, all sharing the same distribution transformer. Each of these homes will have a smart PV inverter, and other DER. To carry out the testing, it is necessary to be able to monitor and manage these entire sets of equipment in a collective and cohesive way.

The Recipient shall:

- Accomplish monitoring and control using all open standards. This is important in order to make the work of this project directly relevant to the Rule 21 proceedings and to be able to share work with the retail market in the near future.
- Provide energy management consoles for each home involved in the field testing.
- Develop communication capability to connect to the equipment.
- Implement in these consoles the algorithms from Task 4 needed to carry out each field test step.
- Test the communication and monitoring system provided in this task.
- Prepare a *Summary Report* describing the communication and monitoring system and testing steps performed.

Exhibit A

Scope of Work

Products:

- Ready and Tested Communication and Monitoring System *Summary Report*

TASK 8 Field Test Plan and Test Execution

The goal of this task is to evaluate on real California distribution systems how the products behave in a real field conditions. The field testing will use the optimal smart inverter settings determined in the modeling and lab testing (Tasks 4 & 5), as well as the algorithms for coordination with other DER (Task 4). Testing in the field will add real-world uncertainties, including noise, voltage variability, real PV variability, and real consumer load behaviors. This will provide a practical view of the methods for enabling more PV identified in Task 4 and a validation of the additional solar levels expected.

The Recipient shall:

- Produce a *Field Test Plan* that sets forth the step-by-step procedures that will be used in the SMUD and SCE field test sites. Unlike the lab testing, field testing does not allow manipulation of the grid voltage or frequency, nor of the PV system outputs. The field test plan will focus on the sequence of smart inverter settings and the collective control algorithms that run across the inverters and other DER in the homes. The test plan will identify the data to be monitored and the analysis to be used to compute the achieved results.
- Execute the test plan, collecting and assessing the data.
- Produce a *Field Test Results Report*

Products:

- Field Test Plan
- Field Test Results Report

TASK 9 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:
 - For Product Development Projects and Project Demonstrations:
 - 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.

Exhibit A Scope of Work

- 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.
- 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 has 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.

Exhibit A Scope of Work

Products:

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

TASK 10 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.

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION - RE: ELECTRIC POWER RESEARCH INSTITUTE, INC.

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

RESOLVED, that the Energy Commission approves Agreement EPC-14-079 from PON-14-310 with **Electric Power Research Institute** for a **\$1,705,478** grant to evaluate advanced inverter functionality to enable higher penetration of photovoltaics (PV) on the grid. The project will identify, implement, and test optimal methods by which smart inverters can mitigate the issues that otherwise would limit local high penetrations of residential PV; 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 June 10, 2015.

AYE: [List of Commissioners]

NAY: [List of Commissioners]

ABSENT: [List of Commissioners]

ABSTAIN: [List of Commissioners]

Harriet Kallemeyn,
Secretariat