

New Agreement EPC-14-035 (To be completed by CGL Office)

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

Recipient's Legal Name	Federal ID Number
Lawrence Berkeley National Laboratory	94-2951741

Title of Project
Demonstration of integrated photovoltaic systems and smart inverter functionality utilizing advanced distribution sensors

Term and Amount	Start Date	End Date	Amount
	5/15/2015	3/29/2019	\$ 1,000,000

Business Meeting Information			
<input type="checkbox"/> ARFVTP agreements under \$75K delegated to Executive Director.			
Proposed Business Meeting Date	4/8/2015	<input type="checkbox"/> Consent	<input checked="" type="checkbox"/> Discussion
Business Meeting Presenter	Zhiqin (Jessica) Zhang	Time Needed:	5 minutes

Please select one list serve. Select

Agenda Item Subject and Description
Possible approval of this agreement with Lawrence Berkeley National Laboratory to install a pilot PV/Storage system and develop innovative control algorithms to test net zero energy capabilities of a test cell in LBNL's facility in the amount of \$1,000,00. (EPIC Funding) Zhiqin (Jessica) Zhang

California Environmental Quality Act (CEQA) Compliance
<p>1. Is Agreement considered a "Project" under CEQA?</p> <p><input checked="" type="checkbox"/> Yes (skip to question 2) <input type="checkbox"/> No (complete the following (PRC 21065 and 14 CCR 15378)):</p> <p>Explain why Agreement is not considered a "Project":</p> <p>Agreement will not cause direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment because</p>
<p>2. If Agreement is considered a "Project" under CEQA:</p> <p><input checked="" type="checkbox"/> a) Agreement <b>IS</b> exempt. (Attach draft NOE)</p> <p><input type="checkbox"/> Statutory Exemption. List PRC and/or CCR section number: _____</p> <p><input type="checkbox"/> Categorical Exemption. List CCR section number: 14 CCR 15301 "Existing Facilities" 14 CCR 15303 "New Construction or Conversion of Small Structures" 14 CCR 15304 "Minor Alterations to Land"</p> <p><input type="checkbox"/> Common Sense Exemption. 14 CCR 15061 (b) (3)</p> <p>Explain reason why Agreement is exempt under the above section:</p> <p>This project will take place at the recipient's existing FLEXLAB buildings. Activities funded under this agreement include installation pre-fabricated photovoltaic (PV) equipment on existing buildings, installation of inverters and batteries mounted to exterior walls of the building, and minor trenching and backfilling to open existing utility corridors and route electrical utilities. The PV system will be one of the many building systems subject to research under the ongoing FLEXLAB research program. Therefore, the project is consists of minor alteration of existing facilities involving negligible expansion of use beyond that existing, installation of small new equipment and facilities in small structures where only minor modifications are made, and minor trenching and backfilling where the surface is restored.</p> <p><input type="checkbox"/> b) Agreement <b>IS NOT</b> exempt. (Consult with the legal office to determine next steps.)</p> <p>Check all that apply</p> <p><input type="checkbox"/> Initial Study <input type="checkbox"/> Environmental Impact Report</p> <p><input type="checkbox"/> Negative Declaration <input type="checkbox"/> Statement of Overriding Considerations</p> <p><input type="checkbox"/> Mitigated Negative Declaration</p>

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

# GRANT REQUEST FORM (GRF)



Legal Company Name:	Budget
Tesla Motors	\$ 14,000
SolarCity	\$ 18,750
Consolidated Engineering	\$ 10,625
	\$
	\$
	\$
	\$
	\$



## Scope of Work

### A. Task List

Task #	CPR <sup>1</sup>	Task Name
1		General Project Tasks
2		Enhance Sensor Network and Communications Integration
3		Data Collection, Analysis, and Event Characterization
4		PV and Storage Deployment at LBNL's FLEXLAB
5	X	Modeling and Simulation
6		Controller Design and Development
7		Controller Pilot and Deployment
8		Evaluation of Project Benefits
9		Technology/Knowledge Transfer Activities

### B. Acronym/Term List

Acronym/Term	Meaning
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CPR	Critical Project Review
FLEXLAB	Facility for Low Energy Experiments
IOU	investor-owned utility
kW	kilowatt
kWh	kilowatt-hour
LBNL	Lawrence Berkeley National Laboratory
PV	Photovoltaic
VirGIL	Virtual Grid Integration Laboratory
ZNE	Zero Net Energy
μPMU	Micro-Phasor Measurement Unit

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

### A. Purpose of Agreement

The purpose of this Agreement is to install a pilot photovoltaic (PV)/storage system, develop innovative control algorithms to test net zero energy capabilities of a test cell in Lawrence Berkeley National Laboratory (LBNL)'s facility and to produce a framework for future developments.

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<sup>1</sup> 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.

## Scope of Work

### B. Problem/ Solution Statement

#### Problem

Today's power distribution networks have limited visibility and diagnostic capabilities and were designed to accommodate a limited number of rotating power generation plants. A future grid with large numbers of distributed, non-rotating solar PV systems will require different and more complex control mechanisms that coordinate control using both utility distribution equipment and solar inverters. As the number of PV installations grows, the grid must evolve to accommodate high penetration levels. Existing instrumentation is limited in its interoperability and deployment to clustered high PV penetration areas. Control schemes are limited and individualized, and do not progressively learn as the distribution grid evolves. The detrimental impact of large volumes of PV on an unprepared grid involve: (1) voltage violations, (2) flicker and other power quality issues, (3) reverse power flow and protection coordination issues, (4) increased wear on utility equipment, and (5) real and reactive power imbalances. Communications and controllers often either allow customers to visualize their PV output over hours or fifteen minutes, or allow utilities to remotely monitor utility-scale PV. There is a lack of development in multi-objective controllers for communities with mixed issues, such as Lawrence Berkeley National Laboratory (LBNL), which has voltage issues, but also net zero energy objectives which could be improved by developing clustered inverter control for highly distributed renewables. There is no framework available to take advantage of a mix of distributed resources and integrate load modeling and control.

#### Solution

This project addresses the following key PV penetration challenges on the distribution grid: real-time visibility of masked load; variability and dynamic voltage impacts; and installation, performance, and cost challenges with the advanced PV technologies and systems. The recipient will develop, demonstrate, and evaluate, at the pilot scale, the ability of an integrated, advanced PV and storage system at a state-of-art test bed in LBNL's Facility for Low Energy Experiments (FLEXLAB). The system includes smart inverter control to enhance and optimize grid support and system performance. The strategy will evaluate the use of distribution synchrophasor units ( $\mu$ PMU) data to support specific visualization and control applications on distribution circuits. The project includes a 13 to 15 kilowatt (kW) PV electric generating system and a 14 kW (56 kilowatt-hour [kWh]) battery storage installation at FLEXLAB. The infrastructure provides an opportunity to thoroughly characterize "before" and "after" installation distribution circuit impacts, as well as to provide a test-bed to investigate smart PV inverter capabilities and distribution circuit optimization and advanced control.

This proposed research will also address the integration problems discussed, by demonstrating and evaluating low-cost monitoring and communications systems, forming the basis for pilot coordinated control systems, using an integrated system of advanced distributed PV, storage, and smart inverters. These control advancements will be designed as a set of open-source control algorithms and applications so that they can be easily transferred to the industry to create an immediate, substantial impact to facilitate the addition of distributed generation and storage.

## Scope of Work

### C. Goals and Objectives of the Agreement

#### Agreement Goals

The goal of this Agreement is to reduce the cost of distributed generation and improve plug-and-play capability by addressing the following barriers:

- Cost of sensors, instrumentation, and controls required for integration
- The lack of visibility of behind-the-meter PV systems
- Slow communications/programmable logic controllers that prevent effective real-time or autonomous control of distributed energy resources to meet specific distribution grid conditions
- The lack of engineering data and guidelines on control and operation of dense PV

Ratepayer Benefits:<sup>2</sup> This Agreement will result in the ratepayer benefits of greater electricity reliability, lower costs, and increased safety. The technology demonstrated here is scalable across investor-owned utility (IOU) territory, and ratepayers will benefit as the technology is deployed across the state. Ratepayers will see improved reliability compared to a case where high-density PV installations exist but are not coordinated and managed as proposed in this agreement. High PV penetration is known to cause variations in delivered voltage on short (e.g., flicker) and moderate (e.g., voltage sag or over voltage conditions) timescales. In addition, real and reactive power imbalances and reverse power flow increase wear and tear on utility equipment, increasing the probability of early failure and power outages. Ratepayers will experience reduced costs because of decreased utility infrastructure spending, increased allowable PV penetration (which offsets retail energy purchases), and increased ability to earn PV-based revenue due to an increase in the type of energy services PV can provide (e.g., using smart inverters for VAR support). When high PV penetration occurs, it is possible to have undetected islanding, which presents a safety risk for ratepayers and utility workers. The work proposed here will improve the ability for PV installations to detect and understand grid conditions and ensure safe operation in the event of grid failures.

Technological Advancement and Breakthroughs:<sup>3</sup> This Agreement will lead to technological advancement and breakthroughs to overcome barriers with maximizing the deployment of distributed generation, and supporting programs such as California Solar Initiative, the New Solar Homes Partnership, and Small Generator Incentives programs by improving the clustered measurement and control of existing and future distributed PV technologies. Distribution measurement and micro-synchrophasor ( $\mu$ PMU) research is in its preliminary stages, but it will provide the link needed to get more solar PV deployed on California distribution grids.

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<sup>2</sup> 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](http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/167664.PDF)).

<sup>3</sup> 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.

## Scope of Work

### Agreement Objectives

The objectives of this Agreement are to:

- Demonstrate correlation between the data collected by the micro-synchrophasor measurement units installed on the LBNL grid and other relevant conditions or anomalies measured on LBNL distribution feeders, including voltage regulation and sags/swells, reverse power flow, and local thermal impacts.
- Collect technical data before and after the installation of the PV and storage, and after the deployment of new controls for mitigation of voltage issues.
- Simulate and demonstrate selected control strategies using distribution modeling and control tools, including the LBNL-developed co-simulation tool Virtual Grid Integration Laboratory (VirGIL), followed by controller development and demonstration.
- Deploy economic and maximizing ZNE objective control strategies, which will work in concert with the new phase angle-based control strategy, allowing the inverters to support the LBNL grid.
- Report on commercial ZNE frameworks tested at LBNL's FLEXLAB facility.
- Collect data to verify the project's economic and technical success, including total energy generated and savings at LBNL, as well as percentage improvement in voltage sags. Compare similar voltage power quality incidents before and after, and report on the success of these strategies.

## Scope of Work

### II. TASK 1 GENERAL PROJECT TASKS

#### PRODUCTS

##### Subtask 1.1 Products

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

##### The Recipient shall:

###### For products that require a draft version

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

###### For products that require a final version only

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

###### For all products

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

- **Electronic File Format**

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

The following describes the accepted formats for electronic data and documents provided to the Energy Commission as products under this Agreement, and establishes the software versions that will be required to review and approve all software products:

- Data sets will be in MS Access or MS Excel file format

## Scope of Work

- (version 2007 or later), or any other format approved by the CAM.
- Text documents will be in MS Word file format, version 2007 or later.
- Documents intended for public distribution will be in PDF file format. The Recipient must also provide the native Microsoft file format.
- Project management documents will be in Microsoft Project file format, version 2007 or later.
- ***Software Application Development***  
Use the following standard Application Architecture components in compatible versions for any software application development required by this Agreement (e.g., databases, models, modeling tools), unless the CAM approves other software applications such as open source programs:
  - Microsoft ASP.NET framework (version 3.5 and up). Recommend 4.0.
  - Microsoft Internet Information Services (IIS), (version 6 and up) Recommend 7.5.
  - Visual Studio.NET (version 2008 and up). Recommend 2010.
  - C# Programming Language with Presentation (UI), Business Object and Data Layers.
  - SQL (Structured Query Language).
  - Microsoft SQL Server 2008, Stored Procedures. Recommend 2008 R2.
  - Microsoft SQL Reporting Services. Recommend 2008 R2.
  - XML (external interfaces).

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

## Scope of Work

### MEETINGS

#### Subtask 1.2 Kick-off Meeting

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

#### The Recipient shall:

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

The administrative portion of the meeting will include discussion of the following:

- Terms and conditions of the Agreement;
- Administrative products (subtask 1.1);
- CPR meetings (subtask 1.3);
- Match fund documentation (subtask 1.7);
- Permit documentation (subtask 1.8);
- Subcontracts (subtask 1.9); and
- Any other relevant topics.

The technical portion of the meeting will include discussion of the following:

- The CAM's expectations for accomplishing tasks described in the Scope of Work;
  - An updated Project Schedule;
  - Technical products (subtask 1.1);
  - Progress reports and invoices (subtask 1.5);
  - Final Report (subtask 1.6);
  - Technical Advisory Committee meetings (subtasks 1.10 and 1.11); and
  - Any other relevant topics.
- Provide an *Updated Project Schedule*, *List of Match Funds*, and *List of Permits*, as needed to reflect any changes in the documents.

#### The CAM shall:

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

#### Recipient Products:

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

#### CAM Product:

- Kick-off Meeting Agenda

#### Subtask 1.3 Critical Project Review (CPR) Meetings

## Scope of Work

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

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

### The Recipient shall:

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

### The CAM shall:

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

### Recipient Products:

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

## Scope of Work

### 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

## Scope of Work

### 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)

## Scope of Work

### 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)

#### CAM PRODUCTS:

- Comments on Draft Final Report Outline

## **MATCH FUNDS, PERMITS, AND SUBCONTRACTS**

### Subtask 1.7 Match Funds

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

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

#### The Recipient shall:

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

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

- A list of the match funds that identifies:
  - The amount of cash match funds, their source(s) (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied.

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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*)

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### **TECHNICAL ADVISORY COMMITTEE**

#### **Subtask 1.10 Technical Advisory Committee (TAC)**

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

- Provide guidance in project direction. The guidance may include scope and methodologies, timing, and coordination with other projects. The guidance may be based on:
  - Technical area expertise;
  - Knowledge of market applications; or
  - Linkages between the agreement work and other past, present, or future projects (both public and private sectors) that TAC members are aware of in a particular area.
- Review products and provide recommendations for needed product adjustments, refinements, or enhancements.
- Evaluate the tangible benefits of the project to the state of California, and provide recommendations as needed to enhance the benefits.
- Provide recommendations regarding information dissemination, market pathways, or commercialization strategies relevant to the project products.

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

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

#### **The Recipient shall:**

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

## Scope of Work

### Products:

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

### Subtask 1.11 TAC Meetings

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

### The Recipient shall:

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

### Products:

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

## III. TECHNICAL TASKS

*Products that require a draft version are indicated by marking “(draft and final)” after the product name in the “Products” section of the task/subtask. If “(draft and final)” does not appear after the product name, only a final version of the product is required. **Subtask 1.1 (Products)** describes the procedure for submitting products to the CAM.*

### **TASK 2 Enhance Sensor Network and Communications Integration**

#### **Subtask 2.1 Installation of new synchrophasor units (μPMUs)**

The goal of this subtask is to install three new μPMUs at LBNL to measure specific voltage and current parameters and to enhance the existing measurement and communication network at LBNL.

## Scope of Work

### The Recipient shall:

- Install two  $\mu$ PMU sensors at the main transformer feed to Building 90, or other appropriate site approved by the CAM, and the FLEXLAB building feed.
- Install a third sensor at the point of connection of the PV/inverter/storage site.
- Integrate communications from new  $\mu$ PMUs with the existing network.
- Determine an optimal communication rate and bandwidth for multiple objectives.
- Integrate a new  $\mu$ PMU stream with the existing data collection information system and develop a *Sample Dataset Report*.

### Products:

- Sample Dataset report.

### Subtask 2.2 Integrate $\mu$ PMU data streams with VirGIL

The goal of this subtask is to take data from the existing  $\mu$ PMU network and integrate with VirGIL.

### The Recipient shall:

- Enhance the simulation framework to incorporate enhanced  $\mu$ PMU data into both the building and grid model.
- Develop *Challenges and Benefits of Integrating  $\mu$ PMU Data with VirGIL Report*. The report shall outline the challenges and benefits of utilizing co-simulation tools with integrated data.

### Products:

- Challenges and Benefits of Integrating  $\mu$ PMU Data with VirGIL Report (draft and final)

### TASK 3 Data Collection, Analysis, and Event Characterization

The goal of this task is to collect operational data from  $\mu$ PMU and the LBNL grid over a three- to six-month period.

### The Recipient shall:

- Develop a library of grid events and impacts of the site before and after installation, including known voltage sag and variability issues.
- Mine  $\mu$ PMU data to select best methods of utilizing the PV for grid support and economic operation.
- Characterize key events on the grid, both short term and longer term. Quantify the impact of events on a larger scale to the whole LBNL grid.
- Determine timing and communication requirements and an event triggering methodology.
- Develop *Data Collection, Analysis, and Event Characterization Report*. This report shall include, but not be limited to, all activities performed under this task.

### Products:

- Data Collection, Analysis, and Event Characterization Report (draft and final)

## Scope of Work

### TASK 4 PV and Storage Deployment at LBNL's FLEXLAB

The goal of this task is to install a research demonstration system for FLEXLAB with PV and storage.

#### The Recipient shall:

- Facilitate installation of a 13–15 kW PV system at FLEXLAB.
- Facilitate installation of a 14 kW Tesla battery at FLEXLAB.
- Select appropriate inverters and storage technology to enable advanced controls.
- Provide materials and installation to the roof of FLEXLAB.
- Integrate a PV pilot site with a load testing cell at FLEXLAB.
- Submit a *Letter of Completion of PV and Storage System Deployment* to inform that the demonstration system including 13-15 kW PV system, 14 kW Tesla battery storage, inverters, advanced controls, and others have been installed at FLEXLAB.

#### Product:

- Letter of Completion of PV and Storage System Deployment

### TASK 5 Modeling and Simulation

#### Subtask 5.1 Integrate, calibrate, and validate an LBNL model in VirGIL

The goal of this subtask is to simulate the LBNL system prior and post PV installation, with calibration and validation from  $\mu$ PMU data in VirGIL. Coordination of PV with existing load model components will be used to demonstrate the most economic deployment of PV and storage for normal operation to reach ZNE goals for commercial buildings.

#### The Recipient shall:

- Utilize existing LBNL infrastructure in VirGIL developed for demand response applications to simulate inverter PV and storage operational information.
- Integrate inverter models and PV irradiance data with the existing model.
- Validate/integrate new  $\mu$ PMU and existing  $\mu$ PMU data.
- Simulate the measured events measured in Task 3.
- Develop control models for inverters to replicate inverter/battery/PV performance.
- Attend CPR meeting, develop *CRP Report*
- Develop *Validation and Modeling of Inverters and Integrated Load and PV Data Report*. The report shall include the simulation results of the LBNL system prior and post PV installation, with calibration and validation from  $\mu$ PMU.

#### Products:

- CPR Report
- Validation and Modeling of Inverters and Integrated Load and PV Data Report (draft and final)

#### Subtask 5.2 Control parameter tuning in simulation mode

The goal of this subtask is to use control models developed in Task 5.1 to output control parameters needed for the inverters to operate in voltage support strategies and take input from the  $\mu$ PMU system.

## Scope of Work

### The Recipient shall:

- Develop and simulate control strategies for an inverter based upon measurements.
- Tune voltage support parameters for the LBNL feeder.
- Enhance models to simulate high penetration on the LBNL feeder, and future control strategies for clusters of PV, utilizing phase-angle and high-fidelity grid measurements.
- Define and implement latency and bandwidth needs from the sensor data integration in the simulation tool.
- Develop *Control Parameter Design and Tuning Report*. This report shall discuss control strategies to use control models developed in Subtask 5.1 to output control parameters needed for the inverters to operate in voltage support and take input from the  $\mu$ PMU system.

### Products:

- Control Parameter Design and Tuning Report (draft and final)

### Subtask 5.3 Advanced inverter and load control analysis

The goal of this subtask is to assess the ability of the  $\mu$ PMUs and communications network to send commands to smart inverters, and to work in coordination with utility distribution equipment to control and optimize the energy produced from PV systems. These inverter response characteristics allow the PV inverter to continue operation during a remote fault and optimize performance in normal operations.

### The Recipient shall:

- Integrate load models with inverter control models developed in subtasks 5.2 and 5.3.
- Identify best practices for low-voltage ride-through setting, voltage sag, and droop response, along with the best economic operation of the site with inverters, energy efficiency, and storage technology.
- Evaluate the current applicable IEEE 1547 and Rule 21 Phase 1, 2, and 3 amendments standard for suitability in controlling grid stability and to allow grid optimization.
- Assess the ability of intelligent utility controls such as the  $\mu$ PMUs to allow future control capabilities of smart inverters.
- Develop *Advanced Inverter and Load Control Analysis Report*. This report shall discuss how  $\mu$ PMUs and communications network send commands to smart inverters, and to work in coordination with utility distribution equipment to control and optimize the energy produced from PV systems.

### Products:

- Advanced Inverter and Load Control Analysis Report (draft and final)

## Scope of Work

### **TASK 6 Controller Design and Development**

The goal of this task is to develop and integrate control and communication algorithms with hardware and software to control inverters and batteries at LBNL. The control algorithms developed for the simulation model in Task 5 will be integrated with the inverter controllers. Telemetry from the grid sensors and inverter will be inputs to the system, and control signals will be sent remotely to the inverter to manage the system economically and in grid-support mode. Data collected will be linked to the controller to enable calculation of benefits in Task 8.

#### **The Recipient shall:**

- Integrate the grid sensor and PV data with the control and communications hardware from Tesla.
- Integrate the control strategy algorithms with the control and communications hardware.
- Prototype algorithm test and safety test the hardware and software in response to control signals.
- Develop and license a *Set of Open Source DG Control Algorithms* that automate the ZNE performance objectives and deliver grid services concurrently
- Develop *Controller Algorithm Design, Integration, and Testing Report*. This report shall discuss how control and communication algorithms can be integrated with hardware and software to control inverters and batteries at LBNL and include licensed set of Open Source DG Control Algorithms.

#### **Products:**

- Controller Algorithm Design, Integration, and Testing Report (Draft and Final)

### **TASK 7 Controller Pilot Demonstration and Deployment**

The goal of this task is to deploy and measure new control schemes for voltage support and mitigation of variability. The controller algorithms will be deployed at the LBNL pilot site and tested extensively over a three- to six-month period. The recipient will quantify the technical and economic benefit of its operation coupled with grid support to enable higher penetrations. As the testing progresses, the control strategy will be enhanced and tuned based upon the response measured on the  $\mu$ PMU data. This strategy will be simulated over numerous conditions of normal and voltage-variable operation at LBNL. Finally, the recipient will perform a cost-benefit analysis of normal operation and integration as a ZNE facility in conjunction with energy efficiency technologies and the benefit of advanced mitigation techniques with inverters and storage.

#### **The Recipient shall:**

- Demonstrate normal operation and low-energy/ZNE facility control objectives and determine how the inverter and storage should be controlled to meet the low-energy facility objectives.
- Deploy the control system for specific voltage sag and variability mitigation objectives, including selection of best practice settings to allow the inverters to ride through (maintain grid connection) and provide support during critical events.

## Scope of Work

- Deploy the coordinated, multi-objective control system to coordinate economic and grid support control. The multi control objectives are ZNE deployment and grid support concurrently.
- Develop *Controller Pilot Demonstration and Deployment Report*. This report shall quantify the technical and economic benefits of controller operation coupled with grid support to enable higher penetrations and perform a cost-benefit analysis of normal operation and integration as a ZNE facility in conjunction with energy efficiency technologies and the benefit of advanced mitigation techniques with inverters and storage.
- Hold a project demonstration workshop.

### Products:

- Controller Pilot Demonstration and Deployment Report (draft and final)
- Project Demonstration Workshop Presentation(s)

### TASK 8 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.
    - 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.

## Scope of Work

- 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 have resulted in other non-energy benefits.
  - An estimate of energy and non-energy benefits.
  - Data on potential job creation, market potential, economic development, and increased state revenue as a result of 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.
- Respond to CAM questions regarding responses to the questionnaires.

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

### Products:

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

### TASK 9 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

## Scope of Work

- 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)

STATE OF CALIFORNIA

STATE ENERGY RESOURCES  
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION - RE: LAWRENCE BERKELEY NATIONAL LABORATORY

**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-14-035 from PON-14-303 with the **Department of Energy's Lawrence Berkeley National Laboratory (LBNL)** for a **\$1,000,000** grant to install a pilot photovoltaic storage system and develop innovative control algorithms to test net zero energy capabilities of a test cell in LBNL's facility; 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 April 8, 2015.

AYE: [List of Commissioners]

NAY: [List of Commissioners]

ABSENT: [List of Commissioners]

ABSTAIN: [List of Commissioners]

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Harriet Kallemeyn,  
Secretariat