STATE OF CALIFORNIA

GRANTS/CONTINGENT AWARD REQUEST

CEC-270 (Revised 02/10) CALIFORNIA ENERGY COMMISSION

To: Grants and Loans Office Date: 7/24/2012

Project Manager: Prab Sethi Phone Number: 916-327-1302
Office: Energy Generation Research Office Division: Energy Research and Development MS- 43
Project Title: Biogas-Powered Microturbine with Ultra-low Emissions for CHP Applications

Type of Request: *(check one)*

☐ **New Agreement:** *(include items A-F from below)* Agreement Number:
Program: PIER NG / Renewables
Solicitation Name and/or Number:
Legal Name of Recipient: DOE- Lawrence Berkeley National Laboratory
Recipient's Full Mailing Address: 1 CYCLOTRON RD STOP 90R1121
BERKELEY, CA 94720-8120
Recipient's Project Officer: David Littlejohn Phone Number: 510-486-7598
Agreement Start Date: 7/1/2008 Agreement End Date: 3/31/2013

☒ **Amendment :** *(Check all that apply)* Agreement Number: PNG-07-004
☒ Term Extension – New End Date: 3/31/2014
☒ Work Statement Revision *(include Item A from below)*
☒ Budget Revision *(include Item B from below)*
☐ Change of Scope *(include Items A – F as applicable from below)*
☐ Other:

ITEMS TO ATTACH WITH REQUEST:

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

California Environmental Quality Act (CEQA)

☐ CEC finds, based on recipient's documentation in compliance with CEQA:
☐ Project exempt: NOE filed:
☐ Environmental Document prepared: NOD filed:
☐ Other:
☒ CEC has made CEQA finding described in CEC-280, attached

Funding Information:

*Source #1: Amount: $ Statute: FY: Budget List #:
*Source #2: Amount: $ Statute: FY: Budget List #:
*Source #3: Amount: $ Statute: FY: Budget List #:

If federally funded, specify federal agreement number:

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

Business Meeting Approval: *(refer to Business Meeting Schedule)*

Proposed Business Meeting Date: 9/12/2012 ☒ Consent ☐ Discussion
Business Meeting Participant: Prab Sethi Time Needed:

Agenda Notice Statement: *(state purpose in layperson terms)*

Possible approval of a ☒ Grant / ☐ Contingent Award to…
Possible approval of Amendment 2 to Agreement PNG-07-004 with Lawrence Berkeley National Laboratory for a 12-month no-cost time extension, change in host site for testing microturbine using digester gas, and to shift remaining development and demonstration work to the existing subcontractor UC Irvine Combustion Laboratory. (PIER Natural Gas funding.) Contact: Prab Sethi.

Project Manager	Date	Office Manager	Date	Deputy Director	Date

Scope of Work

Department of Energy

Funds-In Agreement for Research and Development

Appendix A—California Energy Commission
Statement of Work Including Task Products, Schedule, and Budget
Lawrence Berkeley National Laboratory

I. Title of Project

Biogas-Powered 100 kW Microturbine with Ultra-Low Emissions for Combined Heat and Power (CHP) Applications

II. California Energy Commission Solicitation Identification

Renewable Natural Gas Alternative Biogas and Hybrids Solicitation - PIER

III. Background

The U.S. Department of Energy has directed Lawrence Berkeley National Laboratory to perform the work stated in this Appendix A for the California Energy Commission. Lawrence Berkeley National Laboratory, a laboratory owned by the Department of Energy, is located at 1 Cyclotron Road, MS90R2000, Berkeley, CA 94720. Lawrence Berkeley National Laboratory, a not-for-profit corporation organized under the laws of the State of California, with its principal place of business at 1111 Franklin, Oakland, CA 94607, manages and operates Lawrence Berkeley National Laboratory under DOE Contract No. DE-AC02-05CH11231.

The California Energy Resources Conservation and Development Commission (California Energy Commission) is an agency organized under the laws of the State of California with a principal place of business at 1516 Ninth Street, Sacramento, California 95814. The California Energy Commission will co-fund this project.

IV. Project Goals and Objectives

Develop and demonstrate a recuperated microturbine with an integral low swirl ultra-low emission combustor designed for operation on biogas which is capable of meeting the California Air Resources Board (CARB) ~~2007~~ **2013** distributed generation emission standards for ~~fossil~~ **waste and biogas** fuels. Operation on biogas will be demonstrated at the ~~East Bay Municipal Utility District (EBMUD)~~ **Chiquita** wastewater treatment facility in ~~Oakland~~ **Rancho Santa Margarita**, CA. The unit will be used at the facility. This installation will allow use of biogas in place of natural gas for power generation at the facility.

The increasing restrictions on emissions from distributed generation facilities have the potential to inhibit utilization of biogas resources in California for replacement of natural gas and for increased power generation unless emission reductions from generators can be achieved. New turbine combustors are needed that can meet the more stringent emissions standards and maintain high system efficiency and reliability while operating on biogas and other low heat content fuels.

V. Technical and Economic/Cost Performance Objectives

The overall technical goal of this project is to focus on controlling emissions from a biogas-

powered system, and we will use commercially available equipment for cleaning up the biogas from the digester. No development of new fuel treatment methods is planned under this project, and would require substantially more funding. We will monitor developments in the area of biogas treatment, and incorporate cost effective new technology in our installation if it becomes available during the project time frame.

A. The specific technical objectives of this project are to:

- Develop a microturbine-based CHP package capable of operating on biogas with ultra-low emissions that satisfies the ~~2007~~ **2013** CARB standards for ~~fossil~~ **waste and biogas** fuels.
- Achieve a net system efficiency of >65% from the biogas-powered microturbine CHP package.
- Develop a low swirl combustor for the microturbine that displays stable operation and low emissions with biogas with a range of heat contents that is suitable for many biogas sources in the state, including landfills, wastewater treatment plants, and dairies.
- Develop a microturbine with a low swirl combustor that has at least 50% turndown while maintaining ultra-low emissions that satisfy the **2013** CARB requirements, so that the system will operate on a range of fuels, from low heat content biogas to natural gas while achieving satisfactory emissions.

B. The specific, economic/cost objectives upon which project's success will be evaluated are:

- Operate a microturbine on biogas and meet CARB emissions requirements without expensive post-combustion exhaust clean-up.
- Achieve microturbine operation on biogas with a normal maintenance cycle, and avoid frequent maintenance associated with catalytic combustors.
- Demonstrate the ability for microturbines to transition to the CARB ~~2008 and~~ 2013 emission standards for waste gas with small incremental cost (< 20% of the turbine cost).

Glossary

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

Acronym	***Definition***
CHP	Combined Heat and Power
CPR	Critical Project Review
DOE	U.S. Department of Energy
LBNL	Lawrence Berkeley National Laboratory
LSC	Low Swirl Combustor
M&O	Management and Operating
PIER	Public Interest Energy Research
~~EBMUD~~	~~East Bay Municipal Utility District~~
UCICL	U.C. Irvine Combustion Laboratory
~~SCS~~	~~SCS Energy~~

VI. Preliminary Activities

1.1 Attend Kick Off Meeting

The Recipient shall attend a "kick off" meeting with the California Energy Commission Project Manager to review the California Energy Commission's expectations for: accomplishing tasks described in the work statement; administrative requirements in the terms and conditions of the contract (e.g., invoicing, statements vesting title, prior approvals, data disclosure limitations, monthly progress reporting format and content, etc.); and the California Energy Commission's roles and responsibilities. The location of this meeting shall be designated by the California Energy Commission Project Manager.

Products: Updated schedule of products and updated work plan.
Due Date: July 31, 2008

1.2 Describe Synergistic Projects

No synergistic projects are identified.

1.3 Document Matching Funds

The Recipient shall provide documentation of match fund commitments to the Commission Project Manager. The Recipient shall provide the following information about the match funding to be used to conduct this project (1) Amount and source of each cash match, including a contact name, address and telephone number, (2) Description, documented market or book value, and source of each in-kind contribution, including a contact name, address and telephone number, and the address where the property is located, (3) Written commitment from each source of cash match funding or in-kind contributions that these funds or contributions have been secured or will be secured prior to the date(s) when the funds or in-kind contributions are required for project expenditures.

1.4 Identify Required Permits

Prepare and submit to the California Energy Commission Project Manager a list of all permits required for construction and/or operation of equipment or the project facility, the name, address and telephone number of the permitting jurisdictions or lead agencies, and the schedule the Recipient will follow in applying for and obtaining these permits.

If no permits are required to conduct this project, state this finding.

The Recipient shall contact ~~the Bay Area AQMD and~~ the California ARB to determine the need for a permit for the planned system demonstration. If the regulatory agencies determine that a permit is necessary, apply for a permit in a timely fashion.

Product: A signed letter from CARB or **the local air district** ~~BAAQMD~~ waiving the requirement for a permit OR an approved permit from CARB or **the local air district** B~~AAQMD~~ allowing operation of the microturbine at ~~EBMUD~~ **the Chiquita facility**.
Due Date: ~~February 28, 2009~~ **October 31, 2013**

1.5 Prepare Production Readiness Plan

The Recipient shall confer with subcontractors to prepare a draft production readiness plan for ultra-low emission, biogas-powered, recuperated microturbines and submit to the Commission Project Manager for

review and comments. Recipient shall finalize the production readiness plan by incorporating changes requested by the Commission Project Manager.

Product: Draft Production Readiness Plan
Due Date: ~~March 31, 2012~~ **February 28, 2013**

Product: Final Production Readiness Plan
Due Date: ~~April 30, 2012~~ **March 31, 2013**

1.6 Technology Transfer

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

The Recipient shall work with subcontractors to identify suitable outlet for communication the results and findings of this project.
The Recipient shall report key findings at technical conferences relating to distributed generation and biogas utilization.

The Recipient shall prepare one or more articles for publications that report the results of this project.

Product: Presentations and publications of the results obtained from this project.
Due Date: May 31, ~~2012~~ **2013**

VII. Description of Tasks to be Performed

The overall project summary is provided under "Project Goals and Objectives." LBNL will be responsible for the overall management of this project, will use subcontractors, and will submit the required products to the California Energy Commission as indicated throughout this Work Statement.

Technical descriptions for the various tasks are described below:

Task 2.1	Establish subcontracts with U.C. Irvine Combustion Laboratory ~~and SCS Energy~~
Task 2.2	Design and Fabrication for Biogas-Powered Recuperated Microturbine
Task 2.3	Test and optimize Low Swirl Combustor and Recuperated Microtubine on simulated biogas at Lawrence Berkeley National Lab and U.C. Irvine Combustion Laboratory
Task 2.4	Site preparation at ~~EBMUD~~ **Chiquita** Wastewater Treatment Facility
Task 2.5	~~Installation and commissioning of~~ **Maintenance on the** fuel treatment system **for the** microturbine
Task 2.6	Test, optimize and demonstrate microturbine performance on biogas from ~~EBMUD~~ **Chiquita** facility

Task 2.1 Establish Subcontracts with U.C. Irvine Combustion Laboratory ~~and SCS Energy~~

The goal of this task is to formalize the agreements between the subcontractors and LBNL, the contract lead by establishing subcontracts with U.C. Irvine Combustion Laboratory, for the microturbine development~~, and SCS Energy, for installation~~ **maintenance** of the fuel treatment system and the microturbine at ~~EBMUD~~ **Chiquita**.

Scope of Work

The Recipient shall:

- Develop a draft agreement with a subcontractor, U.C. Irvine Combustion Laboratory, for engineering of a recuperated microturbine adapted to the low swirl combustor and operation on biogas. This agreement will include testing on simulated biogas at UCICL **and installation and operation of the modified microturbine at the Chiquita facility**. The draft agreement shall be submitted to the Commission Project Manager for review and approval. Once approved, Recipient shall fully execute agreement and provide a fully executed copy of the agreement to the Commission Project Manager.

- ~~Develop a draft agreement with a subcontractor, SCS Energy, for installation of the fuel treatment system and the Capstone microturbine at EBMUD. The draft agreement shall be submitted to the Commission Project Manager for review and approval. Once approved, Recipient shall fully execute agreement and provide a fully executed copy of the agreement to the Commission Project Manager.~~

Product: Draft subcontracts with U.C. Irvine Combustion Laboratory ~~and SCS Energy~~.
Due Date: May 31, ~~2010~~ **2012**

Product: Copies of fully executed subcontracts with U.C. Irvine Combustion Laboratory ~~and SCS Energy~~.
Due Date: June 30, ~~2010~~ **2012**

Key Personnel and Subcontractors:

- David Littlejohn **and Robert K. Cheng**
- U.C. Irvine Combustion Laboratory
- ~~SCS Energy~~

Task 2.2 Component Design and Fabrication for Biogas-Powered Recuperated Microturbine
The goal of this task is to design and fabricate the hardware for microturbine-based CHP system to be demonstrated at ~~EBMUD~~ **Chiquita**.

The Recipient shall:

- Design and fabricate a low swirl combustor optimized for operation on biogas.

- Ensure that the combustor will interface properly with the recuperated microturbine produced by Capstone.

- ~~Design a~~ **Assess the** fuel treatment system to clean up the biogas from ~~EBMUD~~ **Chiquita**.

- Prepare and submit to the Commission Project Manager for review and comment a draft and Design Report for the low swirl combustor that is optimized for operation with biogas, and the interface for the low swirl combustor to the recuperated Capstone microturbine. In addition, the report shall demonstrate that the fuel treatment system is capable of providing clean, dry biogas to the microturbine.

- Based on comments received from the Commission Project Manager, Recipient shall prepare and submit a final Design Report to the Commission Project Manager.

- Prepare and submit to the Commission Project Manager for review and comment a draft Fabrication Report for the low swirl combustor, the interface and any other components needed to integrate the low swirl combustor with the Capstone microturbine.

- Based on comments received from the Commission Project Manager, Recipient shall prepare and submit a final Fabrication Report to the Commission Project Manager.

The low swirl combustor (LSC) design will be used for operation with the larger biogas fuel flows needed to achieve the rated power output for the microturbine. It will be designed to operate at the air flow rates and higher temperatures associated with the recuperated microturbine. The combustor will be fabricated at the LBNL mechanical shop. LBNL will design components in consultation with Capstone to adapt their recuperated microturbine, which currently has an annular combustor, to interface with the low swirl combustor in silo configuration. The Recipient shall ensure these components are fabricated. The biogas from the ~~EBMUD~~ **Chiquita** digesters has significant moisture, siloxanes, and sulfur. These components must be controlled to avoid degradation of the microturbine components.

Product: Draft Design Report
Due Date: June 1 2010

Product: Final Design Report
Due Date: July 1, 2010

Product: Draft Fabrication Report
Due Date: June 1, 2010

Product: Final Fabrication Report
Due Date: July 1, 2010

Key Personnel and Subcontractors:

- David Littlejohn
- UCICL

[1ST CRITICAL PROJECT REVIEW. SEE SECTION VIII FOR DETAILED REQUIREMENTS.]

Task 2.3 Test and Optimize Low Swirl Combustor and Recuperated Microturbine on Simulated Biogas at LBNL and at UCICL

The goal of this task is to test the low swirl combustor on simulated biogas at LBNL **and at UCICL**, to integrate the LSC with the microturbine, and to test and optimize the combustor-microturbine system. At the conclusion of testing, the unit will be shipped to ~~EBMUD~~ **Chiquita**.

The Recipient shall:

- Prepare and submit to the Commission Project Manager for review and comment a draft Test Plan for testing the combustor and microturbine on simulated biogas.

- Based on comments received from the Commission Project Manager, Recipient shall prepare and submit a final Test Plan.

Scope of Work

- Test the low swirl combustor on simulated biogas at LBNL.
- Assess the range of fuel heat content values that are suitable for low-emission operation.
- Ship the LSC to UCICL for **testing on natural gas and simulated biogas.**
- **Work with UCICL and Capstone to complete** integration o**f the combustor** with the recuperated microturbine.
- Oversee the testing of the LSC-microturbine system at the UCICL facilities.
- Arrange for any modification of the components as necessary to optimize the performance when operating on simulated biogas.
- Submit notification to Energy Commission Project Manager when the microturbine is shipped by UCICL to ~~EBMUD~~ **Chiquita**.
- Prepare and submit to the Commission Project Manager for review and comment a draft Test Report summarizing the results of the tests conducted at LBNL and UCICL on simulated biogas.
- Based on comments received from the Commission Project Manager, Recipient shall prepare and submit a final Test Report.

The low swirl combustor will first be tested at LBNL at atmospheric conditions and modified as needed to optimize its performance. The combustor will be shipped to UCICL for testing at engine pressure. It will be integrated with the recuperated microturbine modified to operate with a silo combustor. The system will be tested on simulated biogas, and modified as necessary to meet the performance goals. The range of fuel heat contents that provides satisfactory performance will be established. The unit will be shipped to ~~EBMUD~~ **Chiquita**.

Product: Draft Test Plan
Due Date: August 30, ~~2010~~ **2012**

Product: Final Test Plan
Due Date: September 30, ~~2010~~ **2012**

Product: Notification of shipment of microturbine to ~~EBMUD~~ **Chiquita**.
Due Date: October 31, ~~2010~~ **2012**

Product: Draft Test Report
Due Date: December 31, ~~2010~~ **2012**

Product: Final Test Report
Due Date: February 28, ~~2011~~ **2013**

Key Personnel and Subcontractors:

- David Littlejohn**, Robert K. Cheng, and Vince McDonell**
- UC Irvine Combustion Laboratory

[2ND CRITICAL PROJECT REVIEW. SEE SECTION VIII FOR DETAILED REQUIREMENTS.]

Task 2.4 Site Preparation at ~~EBMUD~~ Chiquita Wastewater Treatment Facility
The goal of this task is to prepare a site at the ~~EBMUD~~ **Chiquita** for performing the demonstration of the LSC-microturbine system operating on biogas.

The Recipient shall:

- ~~Order~~ **Insure that** the fuel treatment components **are functional**.
- Arrange with ~~EBMUD~~ **Chiquita** engineers for preparation of a suitable space for the test components and interconnects for power, water, biogas supply, and exhaust system.
- Oversee the ~~installation~~ **maintenance** of the fuel treatment system and confirm that the system is functioning properly.
- Prepare and submit to the Commission Project Manager for review and comment a draft Site Preparation Report for the fuel treatment system and the microturbine at ~~EBMUD~~ **Chiquita**.
- Based on comments received from the Commission Project Manager, Recipient shall submit a final Site Preparation Report.

The components for the fuel treatment system will be specified and ordered by the LBNL purchasing department **or UCICL** for delivery at the ~~EBMUD~~ **Chiquita** facility **as needed**. The location of the installation site at ~~EBMUD~~ **Chiquita** will be identified and arrangements will be made to prepare the appropriate connections for power, CHP, water, biogas fuel, and exhaust gas. The fuel treatment components will be installed and checked to confirm proper function. Preparations will be made for installation of the microturbine.

Product: Draft Site Preparation Report
Due Date: December 31, ~~2010~~ **2012**

Product: Final Site Preparation Report
Due Date: January 31, ~~2011~~ **2013**

Key Personnel and Subcontractors:
- David Littlejohn**, Robert K. Cheng, and Vince McDonell**
- ~~EBMUD~~ **UCICL and Chiquita**

Task 2.5 Installation and Commissioning of Fuel Treatment System and Microturbine
The goal of this task is to install and commission the recuperated microturbine with the low swirl combustor at ~~EBMUD~~ **Chiquita**.

The Recipient shall:

- Install the microturbine system at ~~EBMUD~~ **Chiquita**.
- Ensure that the fuel treatment system is function properly.
- Conduct short-term tests of the system on biogas and confirm proper operation.
- Prepare and submit to the Commission Project Manager for review and comment a draft Installation and Commissioning Report.
- Based on comments received from Commission Project Manager, Recipient shall submit a final Installation and Commissioning Report to the Commission Project Manager.

The delivered microturbine will be checked out at ~~EBMUD~~ **Chiquita** to ensure that no damage occurred during shipment. It will be installed at the test site and the interconnections will be tested to ensure the system is installed properly and its operation will not interfere with the operation of the facility. The unit will be commissioned, and short-term testing will be conducted to assess the system performance.

Product: Draft Installation and Commissioning Report
Due Date: February 28, ~~2011~~ **2013**

Product: Final Installation and Commissioning Report
Due Date: March 31, ~~2011~~ **2013**

[3RD CRITICAL PROJECT REVIEW. SEE SECTION VIII FOR DETAILED REQUIREMENTS.]

Task 2.6 Test, Optimize and Demonstrate Microturbine Performance on Biogas from ~~EBMUD~~ Chiquita Facility

The goal of this task is to operate the microturbine-based CHP system for 6 months to 12 months to assess the system performance.

The Recipient shall:

- Prepare and submit to the Commission Project Manager for review and comment a draft Biogas Test Plan for the installed microturbine system.

- Based on comments received from the Commission Project Manager, Recipient shall prepare and submit a final Biogas Test Plan.

- Operate the microturbine system for six to twelve months on biogas.

- Monitor the system performance to assess the emissions, electrical output, and useable heat output.

- Prepare and submit to the Commission Project Manager for review and comment a draft Biogas Test Report.

- Based on comments received from the Commission Project Manager, Recipient shall prepare and submit a final Biogas Test Report.

The microturbine CHP system will be operated on biogas at ~~EBMUD~~ **Chiquita** while the emissions, electrical output, and CHP heat output are monitored. While the intent is to demonstrate continuous operation, the unit may be shut down briefly to inspect or modify the CHP system components or the fuel treatment system. The participants will determine how the system will be utilized at the end of the demonstration period.

Product: Draft Biogas Test Plan
Due Date: December 31, ~~2010~~ **2012**

Product: Final Biogas Test Plan
Due Date: January 31, ~~2011~~ **2013**

Product: Draft Biogas Test Report
Due Date: February 28, ~~2012~~ **2013**

Product: Final Biogas Test Report
Due Date: March 31, ~~2012~~ **2013**

Task 3.1 Monthly Progress Reports
The Recipient shall prepare written Monthly Progress Reports and submit them to the Commission Project Manager in accordance with the terms and conditions of this agreement.

Product: Monthly Progress Reports
Due Date: Due by the 5th of each month during the approved term of this Agreement.

Key Personnel:

- David Littlejohn**, Robert K. Cheng, and Vince McDonell**

Task 3.2 Final Report
The Final Report shall be a public document.

Task 3.2.1 Final Report Outline

The Recipient shall prepare and submit to the Commission Project Manager for review an outline of the Final Report describing the original purpose, approach, results, and benefits of the project.

The outline shall be submitted to the Commission Project Manager who shall determine if the outline is satisfactory. If the Commission Project Manager determines that the outline is unsatisfactory, he or she will, in a timely manner, provide the Recipient written comments which indicate how the outline can be improved. The recipient shall revise the outline to meet the Commission Project Manager's requirements. Upon finding the final report outline satisfactory, the Commission Project Manager shall provide written approval to the Recipient.

Product: Draft Outline
Due Date: January 31, ~~2012~~ **2013**

Product: Final Outline
Due Date: February 28, ~~2012~~ **2013**

Task 3.2.2 Draft Final Report

The Recipient shall prepare and submit to the Commission Project Manager a draft Final Report on the project. The format of the report shall follow the approved outline and adhere to PIER Program Reports Style Manual which can be accessed at http://www.energy.ca.gov/contracts/pier/contractors/index.html.

The draft final report shall be submitted to the Commission Project Manager for review and approval. If the Commission Project Manager determines that it is unsatisfactory, he or she will provide to the Recipient in a timely manner written comments which indicate how it can be improved. The Recipient shall revise the draft final report incorporating the Commission Project Manager's corrections and required changes. Upon finding the revised draft to be satisfactory, the Commission Project Manager shall provide to the Recipient written approval.

Product: Draft Final Report
Due Date: March 31, ~~2012~~ **2013**

Key Personnel:

- David Littlejohn**, Robert K. Cheng, and Vince McDonell**

Task 3.2.3 Final Report

The Recipient shall prepare the Final Report and submit it to the Commission Project Manager after receiving the Commission Project Manager's written approval of the draft Final Report. This task shall be deemed complete and accepted by the Commission only when the Commission Project Manager (with the consent of the Commission Program Manager) approves the Final Report in writing. Upon approval, the Recipient shall submit two unbound copies and an electronic copy of the Final Report to the Commission Project Manager.

Product: Final Report
Due Date: May 30, ~~2012~~ **2013**

Key Personnel and Subcontractors:

- David Littlejohn**, Robert K. Cheng, and Vince McDonell**

Task 3.3 Final Meeting
The Recipient shall meet with the Commission Project Manager and the Commission Project Manager to present findings, conclusions, and any closeout items.

Product: Minutes of the meeting and/or a copy of the Final Presentation, if any.
Due Date: June 30, ~~2012~~ **2013**

Key Personnel:

- David Littlejohn**, Robert K. Cheng, and Vince McDonell**

VIII. Critical Project Reviews

The California Energy Commission will conduct critical project reviews at the conclusion of the following tasks:

Task 2.2 Design and fabrication for Biogas-Powered Recuperated Microturbine

Task 2.3 Test and optimize Low Swirl Combustor and Recuperated Microturbine on simulated biogas at LBNL and at UCICL

Task 2.5 Installation and commissioning of Fuel Treatment System and Microturbine

A critical project review is a meeting between the Recipient, the Commission Project Manager, and other individuals selected by the Commission Project Manager to provide objective, technical support to the Commission. The purpose of the meeting is to discuss the status of the project and its progress toward achieving its goals and objectives. These meetings may take place at the Commission offices in Sacramento or at another reasonable location determined by the Commission Project Manager.

Prior to each critical project review meeting, the Recipient shall provide the task product(s) to the Commission Project Manager sufficiently in advance to allow the Project Manager's review of the product(s) before the review meeting. If not already defined in the Work Statement, the Commission Project Manager shall specify the contents of the product(s).

At the critical project review meeting, the Recipient shall present the required technical information and participate in a discussion about the project with the Commission Project Manager and other meeting attendees, if any.

Following that meeting, the Commission Project Manager will determine whether the Recipient is complying satisfactorily with the Work Statement and whether the project is demonstrating sufficient progress toward achieving its goals and objectives to warrant continued financial support for the project. If the Commission Project Manager concludes that satisfactory progress is not being made, this conclusion will be referred to the Commission's Research, Development and Demonstration Policy Committee for its concurrence. As an outcome of each critical project review, the Commission Project Manager will provide a written response to the Recipient indication his or her conclusions about the project to date. If appropriate, a written response from the Commission's Grant Officer may direct the Recipient in writing to discontinue a specific task or to cancel any future work.

For each CPR, the Recipient shall:

- Prepare a draft CPR Report and submit to the Commission Project Manager that discusses the progress of the project toward achieving its goals and objectives and makes recommendations regarding continued work on the project.

- Based on comments received from Commission Project Manager, Recipient shall prepare a final CPR Report and submit to the Commission Project Manager.

- Make a presentation at each CPR meeting to review the progress of the project.

- Discuss the status of the project with the Commission Contract Manager.

The CPR reports will provide a compilation of the results of the work conducted under this agreement, and will discuss the goals achieved by the project. The reports will also discuss any need for revising the approach to future tasks.

Product: Draft CPR Report #1 for the Component Design and Fabrication in Task 2.2
Due Date: July 1, 2010

Product: Final CPR Report #1
Due Date: July 1, 2010

Product: Draft CPR Report #2 for results of testing at LBNL and UCICL in Task 2.3
Due Date: December 1, ~~2010~~ **2012**

Product: Final CPR Report #2
Due Date: January 1, ~~2011~~ **2013**

Product: Draft CPR Report #3 for installation of the system at ~~EBMUD~~ **Chiquita** in Task 2.5 and demonstration plan
Due Date: January 2, ~~2010~~ **2013**

Product: Final CPR Report #3
Due Date: February 1, ~~2010~~ **2013**

IX. Sponsor's Key Personnel and Agreement Management

A. Prab Sethi, (916) 654-4509, will be the Project Manager and is the official technical contact for the California Energy Commission.

The Sponsor's Project Manager is responsible for the day to day project status, decisions and communications with the Facility Operator Project Manager (Principal Investigator). The California Energy Commission Project Managers will review and approve all project products, reports, and invoices.

The Sponsor may change the Project Manager by notice given to the Facility Operator at any time signed by the Grants Officer of the California Energy Commission.

B. Crystal Willis, (916) 654-5067, will be the Grant Officer for the Agreement and is the official administrative contact for the California Energy Commission.

X. Facility Operator's Key Personnel and Agreement Administration

The Facility Operator is obligated to comply with the terms and conditions of its Management and Operating (M&O) Contract with the DOE when performing work under this agreement. The DOE may require substitution of the named "key personnel" under this agreement should the DOE determine that the services of the Project Manager (Principal Investigator) or other named key personnel are necessary to meet the Facility Operator's M&O Contract obligations to the DOE. Should the DOE direct the Facility Operator to substitute the named key personnel under this agreement, the Facility Operator shall inform the California Energy Commission of the directed substitution in accordance with paragraphs A and B below. In the event that the California Energy Commission does not concur with the substitution of named key personnel as directed by the DOE, this agreement shall be terminated under Article XX, Termination, of the modified terms and conditions.

A. David Littlejohn will be the Project Manager (Principal Investigator) for this project and is the official technical contact for Lawrence Berkeley National Laboratory. **Robert K. Cheng is the alternate Project Manager for this project**.

The Facility Operator's Project Manager (Principal Investigator) is responsible for the day to day project status, decisions, and communications with the Sponsor's Contract Manager. The Facility Operator's Project Manager (Principal Investigator) will review and approve all project products and reports.

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The Facility Operator's Project Manager (Principal Investigator) is designated as "key personnel" under the Agreement. The California Energy Commission reserves the right to prior written concurrence of any substitution of the Project Manager (Principal Investigator).

B. Additional key personnel under this agreement are listed on Attachment A6, List of Contacts and addresses. Facility Operator's key personnel may not be substituted without the California Energy Commission Project Manager's prior written concurrence. Such concurrence shall not be unreasonably withheld. All other personnel may be substituted by Facility Operator, with written notification made to the California Energy Commission Project Manager.

C. Betsy Quayle, (510) 486-5882, will be the Agreement Administrator for this Agreement and is the official administrative contact for Lawrence Berkeley National Laboratory.

XI. Facility Operator's Key Subcontractors

The key subcontractors are listed on Attachment A7, List of Contacts and Addresses. Facility Operator's key subcontractors may not be substituted without the California Energy Commission Project Manager's prior written concurrence may result in a work stoppage of subcontract work. All other subcontractors may be substituted by the Facility Operator, with written notification made to the California Energy Commission Project Manager.

XII. Schedule

Appendix A, Statement of Work, shows the due dates of task products. The program will continue 52 months after advance funding is received by the Regents of the University of California. This Agreement is effective that date on which it is signed by the last of the parties thereto or the date on which the

Facility Operator receives advance funding from the Sponsor.

XIII. Budget

Appendix A, Attachments A2, A3, A4, A5, and A6 show the approved budget for this Agreement.