

WORK STATEMENT

Ultra-Low Emission Integrated CHP Technology Development

Task #	CPR	Task Name
1	-	Administration
2	-	Sensor Screening and Testing
3	-	Catalyst Screening and Specification
4	X	Engine Control and Software Design
5	-	Emissions System Integration
6	X	Low Temperature Absorption Chiller Design
7	X	Field Test
8	-	Technology Transfer Activities
9	-	Commercialization Readiness Plan

Glossary

Term	Definition
CARB	California Air Resources Board
CHP	Combined Heat and Power
CPM	Commission Project Manager
CPR	Critical Project Review
DER	Distributed Energy Resources
OEM	Original Equipment Manufacturer
PIER	<u>Public Interest Energy Research</u>
RD&D	<u>Research, Development, and Demonstration</u>

Introduction

Combined heat and power (CHP) is important to California's energy future and provides a number of tangible benefits including cost savings, improved reliability of service, energy efficiency, reduced fuel consumption, greenhouse gas mitigation, power capacity relief, and improved grid resiliency. According to the California Energy Commission's (Energy Commission) most recent CHP market assessment (report number 500-2005-173), reciprocating engines are key to cost-effectively addressing most of the state's remaining CHP potential and will remain the prime mover of choice for most CHP applications in California through 2020.

Energy Problem Addressed

Engine emission control technology is lagging behind the regulatory requirement for control of criteria pollutant emissions. ~~Furthermore, the market for CHP can be substantially increased by integrating thermal cooling.~~ Engine manufacturers are key to widespread market acceptance of CHP, but they have been unable or unwilling to provide a factory solution to California's emission requirements ~~or to integrate thermal systems into their CHP packages.~~

Project Description

This Agreement includes the development and demonstration of: 1) reciprocating engine emission technologies that achieve emissions lower than CARB's Distributed Generation Certification Regulation 2007 Fossil Fuel Emission Standards [www.arb.ca.gov/energy/dg/2006regulation.pdf]; 2) an up-fit conversion kit for rich-burn engines; and 3) ~~absorption chiller technology that integrates more cost-effectively with engine heat output in a CHP system.~~ The project will evaluate and test promising sensor technologies for monitoring emission performance ~~and accommodating~~ on pipeline natural gas; with applicability to liquefied natural gas, landfill gas, and anaerobic digester gas; develop robust catalyst specifications for effective reduction/oxidation of pollutants; and devise software and air-fuel ratio control (AFRC) strategies for fast response and precise management of combustion and exhaust after-treatment processes of the engine. Laboratory and field testing will be conducted to evolve and validate the best and most practical solution. The project's Technology Transfer Activities will communicate results, and the Commercialization Readiness Plan will detail the road to market for the technologies.

Project Goal

The goal of this project is to integrate advanced emission control techniques on rich-burn engines, achieve and demonstrate emission performance lower than California Air Resources Board (CARB) 2007 guidelines for distributed energy resources (DER)/CHP systems, and ensure sustained compliance.

Project Objectives:

- Identify sensor types and specific models that are suitable for operation on rich-burn engines based on cost-effectiveness, durability, reliability, sensitivity, and compatibility with current and emerging engine control systems.
- Develop a template for a universal emission-control up-fit conversion kit that will be adaptable to original equipment manufacturer (OEM) natural gas-fueled rich-burn engines in the 200-800 kW size range, with a kit cost target of \$15,000-\$40,000 (small to large engines).
- ~~Demonstrate a low-temperature absorption chiller in the field, operating in engine CHP systems, and lower the cost of such absorbers integrated with engine-driven CHP systems. The chiller design targets are to reduce the over-sizing requirement for conventional chillers in low-temperature applications by 30% and increase heat utilization by 10%.~~

TASK 1.0 ADMINISTRATION

MEETINGS

Task 1.1 Attend Kick-off Meeting

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

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

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

- Discussion of the terms and conditions of the Agreement
- Discussion of Critical Project Review (Task 1.2)
- Match fund documentation (Task 1.6)
- Permit documentation (Task 1.7)

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

- The Commission Project Manager’s expectations for accomplishing tasks described in the Scope of Work
- An updated Schedule of Products
- An updated Gantt Chart
- Discussion of Progress Reports (Task 1.4)
- Discussion of Technical Products (Special Conditions)
- Discussion of the Final Report (Task 1.5)

The Commission Project Manager shall designate the date and location of this meeting.

Recipient Products:

- An Updated Schedule of Products
- An Updated Gantt Chart
- An Updated List of Match Funds
- An Updated List of Permits

Due Date: September 1, 2008

Commission Project Manager Product: Kick-off meeting agenda

Due Date: September 1, 2008

Task 1.2 Critical Project Review (CPR) Meetings

The goal of this task is to determine if the project should continue to receive Energy Commission funding to complete this Agreement and, if necessary, make modifications to the tasks, Products, schedule or budget.

CPRs provide the opportunity for frank discussions between the Energy Commission and the Recipient. CPRs generally take place at key, predetermined points in the Agreement, as determined by the Commission Project Manager and as shown in the Technical Task List above.

However, the Commission Project Manager may schedule additional CPRs as necessary, and any additional costs will be borne by the Recipient.

Participants include the Commission Project Manager and the Recipient and may include the Energy Commission Grants Officer, the Public Interest Energy Report (PIER) Program Team Lead, other Energy Commission staff and Management as well as other individuals selected by the Commission Project Manager to provide support to the Energy Commission.

The Commission Project Manager shall:

- Determine the location, date, and time of each CPR meeting with the Recipient. These meetings generally take place at the Energy Commission, but they may take place at another location.
- Send the Recipient the agenda and a list of expected participants in advance of each CPR. If applicable, the agenda shall include a discussion on both match funding and permits.
- Conduct and make a record of each CPR meeting. One of the outcomes of this meeting will be a schedule for providing the written determination described below.
- Determine whether to continue the project, and if continuing, whether or not to modify the tasks, schedule, products, and budget for the remainder of the Agreement, including not proceeding with one or more tasks. If the Commission Project Manager concludes that satisfactory progress is not being made, this conclusion will be referred to PIER Program Management and the Energy Commission's Research, Development and Demonstration Policy Committee for their concurrence.
- Provide the Recipient with a written determination in accordance with the schedule. The written response may include a requirement for the Recipient to revise one or more product(s) *that were included in the CPR*.

The Recipient shall:

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

Recipient Product: CPR Report(s)
Due Date: April 1, 2009, September 1, 2009
Commission Project Manager Products:

Product: Agenda and a List of Expected Participants
Due Date: March 15, 2009, August 15, 2009

Product: Schedule for Written Determination
Due Date: April 1, 2009, September 1, 2009

Product: Written Determination
Due Date: May 1, 2009, October 1, 2009

Task 1.3 Final Meeting

The Goal of this task is to closeout this Agreement.

The Recipient shall:

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

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

The technical portion of the meeting shall present an assessment of the degree to which project and task goals were achieved, findings, conclusions, recommended next steps (if any) for the Agreement, and recommendations for improvements. The Commission Project Manager will determine the appropriate meeting participants.

The administrative portion of the meeting shall be a discussion with the Commission Project Manager and the Grants Officer about the following Agreement closeout items:

- What to do with any equipment purchased with Energy Commission funds (Options)
 - Energy Commission's request for specific "generated" data (not already provided in Agreement products).
 - Need to document Recipient's disclosure of "subject inventions" developed under the Agreement.
 - "Surviving" Agreement provisions, such as repayment provisions and confidential Products.
 - Final invoicing and release of retention.
- Prepare a schedule for completing the closeout activities for this Agreement.

Products:

- Written Documentation of Meeting Agreements
- Schedule for Completing Closeout Activities

Due Date: February 1, 2011

Task 1.4 Monthly Progress Reports

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

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

The Recipient shall:

- Prepare a Monthly Progress Report which summarizes all Agreement activities conducted by the Recipient for the reporting period, including an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. Each progress report is due to the Commission Project Manager within 10 working days of the end of the reporting period. The recommended specifications for each progress report are contained in the terms and conditions of this agreement.

Product: Monthly Progress Reports,

Due Date: The 10th day of each month during the approved term of this Agreement.

Task 1.5 Final Report

The Goal of the Final Report is to assess the project's success in achieving its goals, advancing science and technology, and providing California utility customer benefits.

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

The Final Report shall be a public document.

Task 1.5.1 Final Report Outline

The Recipient shall:

- Prepare a draft outline of the Final Report.
- Submit the draft outline of the Final Report to the Commission Project Manager for review and approval. The Commission Project Manager will provide written comments back to the Recipient on the draft outline within 10 working days of receipt. Once agreement has been reached on the draft, the Recipient shall submit the final outline to the Commission Project Manager. The Commission Project Manager shall provide written approval of the final Outline within 5 working days of receipt.

Product: Draft Outline of the Final Report

Due Date: February 28, 2010

Product: Final Outline of the Final Report

Due Date: March 31, 2010

Task 1.5.2 Final Report

The Recipient shall:

- Prepare a Draft Final Report following the approved outline and the latest version of the PIER Final Report guidelines published on the Energy Commission's web site at [<http://www.energy.ca.gov/contracts/pier/contractors/index.html>] at the time the Recipient begins performing this Task, unless otherwise instructed in writing by the Commission Project Manager.
- Submit the draft Final Report to the Commission Project Manager for review and comment.

- Prepare a Final Report incorporating and responding to the comments of the Commission Project Manager. The Final Report must be completed on or before the end of the Agreement Term.
- Submit one bound copy of the Final Report with the final invoice.

Product: Draft Final Report
Due Date: June 30, 2010

Product: Final Report
Due Date: July 31, 2010

MATCH FUNDS AND PERMITS

Task 1.6 Identify and Obtain Matching Funds

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

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

The Recipient shall:

- Prepare a letter documenting the match funding committed to this Agreement and submit it to the Commission Project Manager at least 2 working days prior to the kick-off meeting. If no match funds were part of the proposal that led to the Energy Commission awarding this Agreement and none have been identified at the time this Agreement starts, then state such in the letter. If match funds were a part of the proposal that led to the Energy Commission awarding this Agreement, then provide in the letter a list of the match funds that identifies the:
 - Amount of each cash match fund, its source, including a contact name, address and telephone number and the task(s) to which the match funds will be applied.
 - Amount of each in-kind contribution, a description, documented market or book value, and its source, including a contact name, address and telephone number and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Recipient shall identify its owner and provide a contact name, address and telephone number, and the address where the property is located.

- Provide a copy of the letter of commitment from an authorized representative of each source of cash match funding or in-kind contributions that these funds or contributions have been secured.
- Discuss match funds and the implications to the Agreement if they are reduced or not obtained as committed, at the kick-off meeting. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide the appropriate information to the Commission Project Manager if during the course of the Agreement additional match funds are received.
- Notify the Commission Project Manager within 10 working days if during the course of the Agreement existing match funds are reduced. Reduction in match funds must be approved through a formal amendment to the Agreement and may trigger an additional CPR.

Products:

- A letter regarding Match Funds or stating that no Match Funds are provided
- A copy of each Match Fund commitment letter (if applicable)

Due Date: At least 2 working days prior to the kick-off meeting

Products:

- Letter that Match Funds were Reduced (if applicable)
- Letter(s) for New Match Funds (if applicable)

Due Date: As necessary, within 10 days of change in match share commitment.

Task 1.7 Identify and Obtain Required Permits

The Goal of this task is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track.

Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement. Although the PIER budget for this task will be zero dollars, the Recipient may show match funds for this task. Permits must be identified in writing and obtained before the Recipient can incur any costs related to the use of the permits for which the Recipient will request reimbursement.

The Recipient shall:

- Prepare a letter documenting the permits required to conduct this Agreement and submit it to the Commission Project Manager at least 2 working days prior to the kick-off meeting. If there are no permits required at the start of this Agreement,

then state such in the letter. If it is known at the beginning of the Agreement that permits will be required during the course of the Agreement, provide in the letter:

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

Product: A letter documenting the Permits or stating that no Permits are required

Due Date: At least 2 working days prior to the Kick-Off Meeting.

Products:

- Updated list of Permits as they change during the Term of the Agreement (if applicable)
- Updated schedule for acquiring Permits as it changes during the Term of the Agreement (if applicable)

Due Date: As necessary, within 10 days of change.

Product: A copy of each approved Permit (if applicable)

Due Date: As necessary, within 10 days of receipt of each permit.

TECHNICAL TASKS WITHIN THE WORK STATEMENT

Unless otherwise provided in the individual Task, the Recipient shall prepare all Products in accordance with the requirements in the Special Conditions.

Task 2 Sensor Screening and Testing

The goal of this task is to develop and laboratory-test a protocol, which would eventually be standardized, for using new sensors to fine-tune air-fuel ratio control (AFRC) and provide on-board diagnostics (OBD) that will maintain reciprocating engine performance below CARB's 2007 distributed generation emission guidelines.

Task 2.1 Sensor Selection

The Recipient shall:

- Establish quantitative criteria for selecting available sensors, based on the following factors: unit cost and documented performance, including estimated life, signal conversion effectiveness, and operational suitability.
- Screen and select sensor technologies, based on the application of the quantitative criteria. Sensor types to be surveyed shall include narrow-band and wide-band O₂ sensors, NO_x/O₂ sensors, heating value sensors, fast-response thermocouples, and in-cylinder pressure transducers suitable for pipeline natural gas, liquefied natural gas, landfill gas, and anaerobic digester gas-fueled internal combustion engines. Screening will include a literature review and discussions/meetings with selected suppliers. The project team will build upon extensive in-house information about afore-mentioned sensors, as well as contacts with developers and suppliers.
- Prepare and submit a Sensor Screening Report, describing the work performed, findings, and recommendations for field testing.

Product: ~~Summary~~ **Draft** Sensor Screening Report

Due Date: ~~February 1, 2009~~ **March 20, 2009**

Product: **Final Sensor Screening Report**

Due Date: **April 17, 2009**

Task 2.2 Sensor Protocol Development

The Recipient shall:

- Develop and submit straw-man protocols for OBD and higher resolution AFRC for the selected sensors.
- Procure the selected sensors.
- Integrate the sensors with required data processing and recording systems for operating a 75-kW Waukesha F817GU engine configured with new, pre-

production Continental Controls EGC4 AFRC and a three-way catalyst designed to reduce emissions below CARB's 2007 distributed generation emission guidelines.

Product: Straw man protocol
Due Date: ~~January 1, 2009~~ **August 21, 2009**

Product: ~~Summary~~ **Draft** Sensor Protocol Report
Due Date: ~~March 1, 2009~~ August 21, 2009
Product: **Final Sensor Protocol Report**
Due Date: **September 25, 2009**

Task 2.3 Sensor Test Plan

The Recipient shall:

- Develop, prepare, and submit a sensor test plan for approval by Commission Project Manager. Test plan will adhere to the ASERTTI laboratory testing and reporting procedures and include the following elements:
 - A description of the protocols to be tested.
 - The rationale for the tests, test objectives and technical approach.
 - A test matrix showing the number of test conditions and replicated runs.
 - A description of the facilities, equipment, and instrumentation that will be used to conduct the tests.
 - A description of test procedures, including parameters to be controlled and how they will be controlled.
 - Parameters to be measured and instrumentation to measure them.
 - Calibration procedures to be used.
 - Recommended calibration interval and maintenance of the test log.
 - A description of the data analysis procedures.
 - A description of quality assurance procedures.
 - Contingency measures to be considered if the test objectives are not met.

Product: Draft Sensor Test Plan
Due Date: ~~March 15, 2009~~ **August 21, 2009**

Product: Final Sensor Test Plan
Due Date: ~~April 15, 2009~~ **September 25, 2009**

Task 2.4 Sensor Testing

The Recipient shall:

- Execute the approved sensor test plan.
- Analyze data obtained from experiments and use it to calibrate or amend required alarm limits and diagnostic codes in the OBD protocols or control algorithms for fine-tuning the AFRC.
- If there are deviations for the test plan they should be explained in the Test Report.
- Prepare and submit a Test Report.

Product: Draft Test Report

Due Date: ~~May 1, 2009~~ **October 29, 2010**

Product: Final Test Report

Due Date: ~~June 1, 2009~~ **December 17, 2010**

Task 3 Catalyst Screening and Specification

The objective of this task is to evaluate catalyst formulations and specifications for select engine platform and to qualify catalyst supplier(s).

The Recipient shall:

- Establish quantitative criteria for selecting among available catalysts, based on the following factors: unit cost and documented performance, including estimated life, criteria pollutants reduction effectiveness, and operational suitability.
- Identify methods for sensing catalyst degradation, sub-par performance, or failure. Such methods may consist of a NO_x sensor, carbon monoxide (CO) sensor, and/or catalyst temperature differential.
- Devise alarm functions to alert CHP operators of the possibility of catalyst malfunction.
- Screen and select catalysts, based on the application of the quantitative criteria. Catalyst types to be surveyed shall include robust 3-way catalyst formulations, multiple stage 3-way catalysts, and oxidation catalyst downstream of the 3-way catalyst suitable for pipeline natural gas, liquefied natural gas, landfill gas, and anaerobic digester gas-fueled internal combustion engines. Screening will include a literature review and discussions/meetings with selected suppliers.

- Identify methods for gas cleaning, if necessary to maintain catalyst performance.
- Perform qualification testing of catalyst solutions exhibiting the best potential at Hawthorne Power Systems or at a catalyst manufacturer's factory to evaluate the performance relative to the established quantitative criteria. (As these tests will be for screening and developmental purposes, a detailed test plan is not required. Catalyst durability testing will be conducted during the field test, which will include a test plan).
- Prepare a Catalyst Screening Report, describing the work performed, findings, and recommendations for field testing.

Product: Draft Catalyst Screening Report

Due Date: ~~May 1, 2009~~ **June 18, 2010 (Part 1); November 31, 2010 (Part 2)**

Product: Final Catalyst Screening Report

Due Date: ~~July 1, 2009~~ **December 17, 2010**

Task 4 Engine Control and Software Design

The objective of this task is to implement, based on Task 2 results, the required software algorithms and hardware support for selected sensors and integrate them into a complete AFRC system.

The Recipient shall:

- Develop a general-purpose integrated emission control system, using Continental's proprietary AFRC technology as the foundation and utilizing their EGC4 hardware platform that will:
 - Specify sensors, sensor control requirements, and installation locations.
 - Implement in software the alarm and control functions necessary for providing measured signals to AFRC based on the findings of Task 2.
 - Implement alarm and control in embedded software and bench test.
- Develop engineering specifications for the complete engine control system, including air/fuel controls hardware; sensors and final control elements; and catalyst formulation and qualifying suppliers, taking into consideration the heat recovery system.
- Prepare and submit an Emission and Engine Control and Software Design Report, including drawings, flow charts, and logic-flow diagrams.

Product: Draft Emission and Engine Control and Software Design Report

Due Date: ~~July 1, 2009~~ **November 5, 2010**

Product: Final Emission and Engine Control and Software Design Report
Due Date: ~~September 1, 2009~~ **December 17, 2010**

[CRITICAL PROJECT REVIEW MEETING. SEE TASK 1.2 FOR DETAILS]

Task 5 Emission System Development

The objectives of this task are to 1) fit the test engine, based on Task 4 results, with the controls system components necessary to shop-test the system; and 2) perform an operational test of AFRC and engine automation system at Hawthorne Power Systems.

The Recipient shall:

- Review drawings and specifications to identify engine installation requirements and assign responsibilities to team members.
- Develop test procedure and define the rationale for the tests, test objectives, and technical approach. Test procedure will include a test matrix showing the number of test conditions and replicated runs and a description of the facilities, equipment, and instrumentation that will be used to conduct the tests.
- Prepare and submit a Test Plan.
- Up-fit engine at ~~Hawthorne Power Systems factory~~ **Continental Controls Corporation**.
- Conduct test on emission and alarm performance in accordance with the Test Plan.
- Make adjustments as warranted.
- Prepare and submit a Emission System Development Report covering work that was performed, findings, and recommendations for modifications to the system, including final system drawings and bills of materials.

Product: Draft Test Plan
Due Date: ~~July 1, 2009~~ **November 5, 2010**

Product: Final Test Plan
Due Date: ~~September 1, 2009~~ **December 17, 2010**

Product: Draft Emission System Development Report
Due Date: ~~October 1, 2009~~ **November 5, 2010**

Product: Final Emission System Development Report
Due Date: ~~November 1, 2009~~ **December 17, 2010**

Task 6 Low-Temperature Absorption Chiller Design

The goal of this task is to **seek prospective field test sites for** ~~site engineer~~ a low-temperature hot-water absorption chiller that will maximize thermal utilization and increase efficiency while reducing greenhouse gas emissions.

The Recipient shall:

- ~~Select a~~ **Evaluate prospective demonstration sites for integration of the absorption chiller engine recovered heat.**
- ~~Assess the site's thermal distribution system, piping, existing cooling equipment, integration points, chiller location, and accessory systems.~~
- ~~Develop a design for the integration of the chiller system with the engine, heat recovery system, building HVAC system, and controls.~~
- ~~Develop specifications for the chiller and accessory equipment, together with a process and instrumentation diagram (P&ID).~~
- ~~Prepare and submit an Absorption Chiller Design Report, covering work that was performed, findings, and recommendations for modifications to the system, including detailed specifications for the chiller system, including P&ID and fabrication and system integration cost estimates.~~

Note: the remaining scope under this task as originally proposed has been eliminated due to difficulty finding a suitable field test site that could accommodate both the emission control and absorption chiller technologies.

~~**Product:** Draft Absorption Chiller Design Report
Due Date: May 1, 2009~~

~~**Product:** Final Absorption Chiller Design Report
Due Date: July 1, 2009~~

[CRITICAL PROJECT REVIEW MEETING. SEE TASK 1.2 FOR DETAILS]

Task 7 Field Test of Reciprocating Engine-Based CHP System

The goal of this task is to show that a stoichiometric-operated, natural gas-fueled, reciprocating engine can maintain exhaust emissions levels below CARB's 2007 distributed generation emission standards for extended periods of operating hours.

The Recipient shall:

- Identify existing stoichiometric engine CHP sites in Southern California with emission compliance ~~and thermal utilization~~ issues.
- Interview site owners for interest in participating in advanced technology test.
- Select field test site.
- Submit a site selection report, including a list of CHP sites with compliance ~~or thermal utilization~~ issues.
- Develop and submit a Long-Term Monitoring Plan (LTMP), consistent with appropriate ASERTTI protocol, including simulated aberrant engine operating conditions to test OBD capabilities.
- ~~Fabricate absorption chiller.~~
- ~~Submit a functionality test report on absorption chiller.~~
- Install advanced emission control ~~and absorption~~ equipment at the site.
- Complete start-up and commissioning testing.
- Obtain and assemble ~~continuous~~ emissions monitoring system (~~CEMS~~).
- Assemble data acquisition and monitoring system and perform any required programming; this will include purchase of data acquisition hardware and remote monitoring capabilities as defined in the LTMP.
- Prepare and submit a Cost Report Including: component costs, fabrication costs, and installation costs.
- Collect substantiating data to document CHP system performance. Monitor CHP engine system performance according to the LTMP for a minimum of 4,000 operating hours, estimated to take ~~1 year~~ **6 months**.
- Prepare and submit Field Test Report.
- Progress reports during this period shall include testing data.

Products:

- Copy of Agreement with field test site owner
- Site Selection Report
- Copies of permits and any documents prepared pursuant to CEQA
- Construction Plan and Schedule
- Draft Long-Term Monitoring Plan

Due Date: ~~December 1, 2009~~ **January 14, 2011**

Product: Final Long-Term Monitoring Plan

Due Date: ~~February 1, 2010~~ **February 11, 2011**

~~**Product:** Absorption chiller functionality test report~~

~~**Due Date:** December 1, 2010~~

Product: Draft Field Test Report

Due Date: ~~January 2, 2011~~ **October 14, 2011**

Product: Final Field Test Report

Due Date: ~~February 1, 2011~~ **November 18, 2011**

~~**[CRITICAL PROJECT REVIEW MEETING. SEE TASK 1.2 FOR DETAILS]**~~

Task 8 Technology Transfer Activities

The Goal of this task is to stimulate market adoption of the technology advances by disseminating information on project results with stakeholders and market participants.

The Objective of this task is to present advances in science and technology made under this project with the peer technical community, other stakeholders, and decision makers in the private and public sectors.

PIER-reimbursable Technology Transfer Activities can include reasonable and necessary efforts and costs associated with the following:

- Presentations and exhibits on PIER-funded RD&D at a technical conference, trade show, public hearing or workshop. Costs associated with the preparation and delivery of the presentation and/or exhibit, a pro-rata share of the conference fee, travel, lodging and per diem expenses.
- Papers published in a trade, scientific, or engineering publication or topical popular magazine.

Unless authorized by the Commission Project Manager in advance, the following are NOT PIER-reimbursable Technology Transfer Activities:

- Attendance at a conference, trade show, meeting, public hearing or workshop at which a team member does not give a presentation on the PIER-funded project.

- Meetings among project team members concerning the project; however, these are reimbursable under Administrative and other Technical Tasks.
- Meetings between a project team member(s) and the Commission Project Manager or any project funder concerning the project; however, these are reimbursable under Administrative and other Technical Tasks.
- Preparation of sales brochures.

However, match funds may be counted for conducting these activities.

The Recipient shall:

- Make presentations and staff exhibits on PIER-funded RD&D at technical conferences, trade shows, public hearings, and/or workshops.
- Write and submit papers for publication on PIER-funded RD&D.
- Identify specific conferences and target audiences for presentations on PIER-funded RD&D activities and results. A summary of relevant activities shall be included in the Final Report for this project.
- Describe planned and completed Technology Transfer Activities in Monthly Progress Reports.
- Provide copies of relevant presentations and papers to the Commission Project Manager.

Products:

- Draft and Final Versions of papers for publication prior to their submittal for publication
- Copies of meeting and conference agendas, presentations, reports, due within 30 days of attendance
- Trip Reports for conferences emphasizing the value of attendance to the project, due within 30 days of attendance
- Appropriate section on Technology Transfer Activities in Monthly Reports, including planned conference presentations and preparation of technical papers

Due Date: Concurrent with Monthly Progress Reporting

Task 9 Commercialization Readiness Plan

The Goal of this task is to forecast the likelihood that the science and technology advancements will result in commercial products.

The Objectives of this task are to identify the actions, time, and funding required to introduce the technology or product developed under this agreement to a commercial and commercially viable

product that will provide California utility customer benefits, to quantify the expected market penetration of the product, and to identify and quantify the California utility customer return on investment.

The Recipient shall:

- Conduct a Technology Readiness Assessment. The assessment shall include, as appropriate, but is not limited to:
 - A milestone chart with dates beginning at the start of this agreement showing significant events such as project completion, alpha unit demonstration, beta unit demonstration, field demonstrations, and commercial product introduction.
 - For each milestone in the milestone chart, describe the research, development, and demonstration or other technological efforts and the approximate cost required to achieve that milestone.
 - An implementation plan to ramp up to full production of a commercial product.
 - Identification of critical production processes, equipment, facilities, personnel resources, and support systems that will be needed to produce a commercially viable product.
 - Internal manufacturing facilities, as well as supplier technologies, capacity constraints imposed by the design under consideration, identification of design critical elements and the use of hazardous or non-recyclable materials.
 - Identification of manufacturing partners.
 - The expected investment threshold to launch the commercial product.

- Conduct a Market Readiness Assessment. The assessment shall include, but is not limited to:
 - Identification and discussion of regulatory and institutional factors that positively or negatively affect the purchase of the technology or product.
 - Identification of the business and commercial relationships that need to be established.
 - Quantification of Technical Market Potential.
 - Quantification of Economic Market Potential.
 - A projection of what the commercial product “should cost” as a function of sales per year.
 - Identification of the classes of customers that will purchase the product. Discussion of the needs and desires that will induce them to buy the product.
 - Identification of competing manufacturers and competing technologies and their expected advantages and disadvantages at the same points in time.
 - Projected selling prices for your product consistent with the projected sales volume and market position.

- Projected rate of penetration of sales of your product/technology in California and elsewhere, including expected sales in each year.
- Conduct a Public Benefits Assessment. Starting from the Market Readiness Assessment and projected market penetration, estimate the California utility customer benefits. The Public Benefits Assessment shall:
 - Identify Sources of public benefits, including, but not limited to:
 - Fuel and electricity savings.
 - Greenhouse Gas Emission reductions.
 - Criteria pollutant emission reductions.
 - Estimated royalty payments by year based on the projected penetration rate given in the Market Readiness Assessment: (Southern California Gas Company Revenues from the contract technology) x (1.5%).
 - Energy supply security.
 - California jobs.
 - Describe a methodology and metric for valuing each public benefit, with a description of the approach for estimating the magnitude of the public benefit.
 - Apply the methodology and tabulate the projected public benefits.
- Prepare a Commercialization Readiness Plan that integrates the findings of the Technology Readiness, Market Readiness and Public Benefits Assessments.

Products:

- Milestone Chart for Technological Achievements, with dates
- Draft Commercialization Readiness Plan

Due Date: ~~October 1, 2010~~ **October 21, 2011**

Product: Final Commercialization Readiness Plan

Due Date: ~~December 1, 2010~~ **November 25, 2011**