

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION - RE: Altex Technologies

RESOLVED, that the State Energy Resources Conservation and Development Commission (Energy Commission) approves Agreement PIR-09-012 to reallocate reimbursable budget funds to reflect revised project team capabilities. There is no time extension and no funds are being added. (PIER electricity funding.) Contact: Mike Kane.

FURTHER BE IT RESOLVED, that this document authorizes the Executive Director to 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 March 14, 2012.

AYE: [List of Commissioners]

NAY: [List of Commissioners]

ABSENT: [List of Commissioners]

ABSTAIN: [List of Commissioners]

Harriet Kallemeyn,
Secretariat

GRANTS/CONTINGENT AWARD REQUEST



To: Grants and Loans Office

Date: 1/5/2012

Project Manager: Mike Kane

Phone Number: 916-327-1530

Office: Energy Generation Research Office

Division: Energy Research and Development

MS- 43

Project Title: Boiler Burner Energy System Technology ("BBEST") for Firetube Boilers

Type of Request: (check one)

Form for New Agreement with fields for Program, Solicitation Name, Recipient Name, Address, Project Officer, and Dates.

Form for Amendment with checkboxes for Term Extension, Work Statement Revision, Budget Revision, Change of Scope, and Other.

ITEMS TO ATTACH WITH REQUEST:

- List of items to attach: A. Work Statement, B. Budget, C. Recipient Resolution, D. Special Conditions, E. CEQA Compliance Form, F. Other Documents.

California Environmental Quality Act (CEQA)

Form for CEQA compliance with checkboxes for CEC finds, project exempt, environmental document, and CEQA finding.

Funding Information:

Funding information table with columns for Source #, Amount, Statute, FY, and 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)

Business Meeting Approval form with fields for Date, Participant, and Consent/Discussion options.

Agenda Notice Statement: (state purpose in layperson terms)

Possible approval of a Grant / Contingent Award to... Possible approval of Amendment 1 to Agreement PIR-09-012 with Altex Technologies Corporation...

**Exhibit A
WORK STATEMENT**

TECHNICAL TASK LIST

Task #	CPR	Task Name
1		Administration
2		Process Analysis and System Design
3		Demonstration Site Selection and Acquisition
4		Select and Acquire ST Johnson Burner <u>Design and Build Ultra Reduced NOx Burner</u>
5		Select and Acquire Elliott Turbec Microturbine
6		Fabricate Integration Components
7	X	System Assembly
8		Preliminary System Tests
9	X	Site Installation and Demonstration Test Plan
10		System Field Testing
11		System Performance and Cost Evaluation
12		Technology Transfer Activities
13		Product Readiness Plan

KEY NAME LIST

Task #	Key Personnel	Key Subcontractor(s)	Key Partner(s)
1	John Kelly Carlo Castaldini Antonio de La O <u>Franco Castaldini</u> Lou Brizzolara	CMC-E (Sub 1) ST Johnson (Sub 2) <u>Leva Energy (Sub 2)</u> AHM (Sub 3)	
2	John Kelly Carlo Castaldini Antonio de La O <u>Franco Castaldini</u>	CMC-E ST Johnson <u>Leva Energy</u>	
3	John Kelly Carlo Castaldini Antonio de La O <u>Franco Castaldini</u> Lou Brizzolara	CMC-E ST Johnson <u>Leva Energy</u> AHM	
4	John Kelly Carlo Castaldini Antonio de La O <u>Franco Castaldini</u> Lou Brizzolara	CMC-E ST Johnson <u>Leva Energy</u> AHM	
5	John Kelly Carlo Castaldini	CMC-E	
6	John Kelly Carlo Castaldini	CMC-E	
7	John Kelly Carlo Castaldini Antonio de La O	CMC-E ST Johnson	

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	<u>Franco Castaldini</u>	<u>Leva Energy</u>	
8	John Kelly Carlo Castaldini	CMC-E	
9	John Kelly Carlo Castaldini Lou Brizzolara	CMC-E AHM	
10	John Kelly Carlo Castaldini Antonio de La O <u>Franco Castaldini</u>	CMC-E ST Johnson <u>Leva Energy</u>	
11	John Kelly Carlo Castaldini Antonio de La O <u>Franco Castaldini</u>	CMC-E ST Johnson <u>Leva Energy</u>	
12	John Kelly Carlo Castaldini Antonio de La O <u>Franco Castaldini</u>	Altex CMC-E ST Johnson <u>Leva Energy</u>	Southern California Gas Company
13	John Kelly Carlo Castaldini Antonio de La O <u>Franco Castaldini</u>	CMC-E ST Johnson <u>Leva Energy</u>	

GLOSSARY

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

Term/ Acronym	Definition
AB	Assembly Bill
ARB	Air Resource Board
ASERTTI	Association of State Energy Research & Technology Transfer Institutions
ASTM	American Society of Testing Materials
BBEST	Boiler Burner Energy System Technology
BMS	Burner Management System
CAD	Computer Aided Design
CHP	Combined Heat and Power
CPR	Critical Project Review
CFD	Computational Fluid Dynamics
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
DAS	Data Acquisition System
DER	Distributed Energy Resources
DG	Distributed Generation

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FD	Forced draft
FGR	Flue Gas Recirculation
GHG	Greenhouse Gases
kW	Kilowatt
kWe	Kilowatt-Electric
MMBtu	Million British Thermal Units
MTG	Microturbine Generator also Microturbines
NO _x	Mono-Nitrogen Oxides
O ₂	Oxygen
ppm	Parts Per Million
PIER	Public Interest Energy Research
QA/QC	Quality Assurance/Quality Control
RD&D	Research, Development and Demonstration
SCMTG	Simple Cycle Microturbine Generator
SCG	Southern California Gas Company
TA	Turbo Alternator
URNB	Ultra Reduced NO _x Burner
UNLB	Ultra Low NO _x Burner

Problem Statement:

Integrated microturbine-burner Combined Heat and Power (CHP) for industrial/commercial boilers has a large potential, given the tens of thousands of existing boilers that could be retrofitted with compact boiler CHP packages. However, new California emissions regulations are a significant barrier to implementation. In addition, at the firetube boiler scales of interest for this project, low capital and operating costs are even more critical. Lastly, besides better emissions and lower costs, customers demand high reliability and operability, as well as attractive payback on investment. The project will address these challenges, using a proven Simple Cycle Microturbine Generator (SCMTG) integrated with an innovative ultralow Mono-Nitrogen Oxides (NO_x) boiler burner that will be joined by an eductor assembly. Current CHP approaches for firetube boilers typically use recuperated Microturbine Generators (MTGs) with or without supplemental firing. Without supplemental firing, excess air is very high and efficiencies are only 60%, which is far below boiler capabilities of over 80%. With supplemental firing, efficiencies can reach 80% at full load. However, as load is reduced, efficiencies quickly fall to 60%. These lower efficiencies represent significant costs to users, which offset the benefits of CHP, including gains in greenhouse gas emissions reductions. Furthermore, recuperated MTGs engine costs are high and durability is not in line with conventional boiler equipment. Lastly, both the MTGs and supplementary firing burner have to be low-NO_x to meet new California regulations. Many low-NO_x burners require high excess air or Flue Gas Recirculation (FGR), which drives up air pumping power costs.

The proposed Boiler Burner Energy System Technology (BBEST) will directly address these barriers confronting conventional boiler CHP systems by (1) using a lower cost non-recuperated simple cycle engine with a simple ultralow NO_x burner; (2) use a low-

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excess-air and low-FGR ultralow NO_x boiler burner that has low operating costs and can meet all proposed firetube boiler emission limits; (3) use a MTG exhaust eductor to eliminate the boiler burner fan and motor, while providing flexibility to address maximum and reduced load conditions with high efficiency. The Recipient believes that the technology will be successful because Sub 1 has demonstrated the low-cost MTG on a large watertube boiler application, and because the Recipient has proven the boiler burner in the field of firetube boilers, and as a duct burner that met California Air Resources Board (CARB) 2007 limits. These prior achievements will reduce risk and help facilitate success under the project. Cost has been a significant barrier to MTG-based CHP because the CHP systems use more complex and less reliable recuperated MTGs developed for standalone Distributed Energy Resources (DER), where power production efficiency is a critical need. With CHP, the critical parameter is \$ / Kilowatt-Electric (kWe) and not efficiency. This deficiency is corrected by using a simple and very low-cost SCMTG and synergistically couple it to a low-cost ultralow NO_x burner to achieve high efficiency, low-priority pollutants and low greenhouse gas emissions. This work needs to be pursued at this time to eliminate the emissions barrier and allow the development of low-cost BBEST for the large firetube boiler market. With this system, the slow adoption of small CHP will be overcome.

Goals of the Agreement:

The goal of this project is to engineer, design, build and demonstrate in the field, an innovative BBEST that will meet challenging CHP and boiler air emissions, minimizing cost and optimizing operability by the synergistic coupling of a proven SCMTG and ultralow NO_x burner. This innovation will directly address the slow adoption of small CHP systems by creating a low-emissions and cost-effective compact power system for retrofit to the large population of firetube boilers in California and elsewhere.

Objectives of the Agreement:

The objectives of this Agreement are to:

- Lower overall firetube boiler emissions to levels below 9 Parts Per Million (ppm) @3% Oxygen (O₂), to meet emissions regulations in all California regions
- Allow boiler operation at low excess air, (2-3% excess O₂) under both full and part load conditions, to minimize sensible (dry gas) heat losses in the stack and reduce fuel costs
- Reduce incremental cost of power generation to less than \$700 / Kilowatt (kW), and provide a payback of 1.5-2.0 years for most 100kWe installations
- Minimize incremental operating and maintenance costs of power generation by exceeding equivalent power conversion efficiencies above 90%, with a reliable compact package
- Achieve overall CHP efficiencies of 82%, by improving boiler-burner operation especially at part loads
- Improve MTG reliability and reduce cost by eliminating recuperator and using a low temperature and low NO_x combustor

The proposed project addresses several barriers with technology developments to further CHP penetration in the California market. If the project is successful, a new

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compact, low emissions and cost-effective CHP technology will become available to address the large firetube boiler market. It is estimated that over 5,000 units in California are candidates for this technology that will yield low emissions, reduced greenhouse gas (GHG) emissions and fuel use, and provide a financial return for users, with less than a 2-year payback.

Product Guidelines:

For complete product guidelines, refer to Section 5 in the Terms and Conditions.

TASK 1 ADMINISTRATION

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
- Discussion of Progress Reports (Task 1.4)
- Discussion of Technical Products (Product Guidelines located in Section 5 of the Terms and Conditions)
- Discussion of the Final Report (Task 1.5)

The Commission Project Manager shall:

- Designate the date and location of this meeting.

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Recipient Products:

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

Commission Project Manager Product:

- Kick-Off Meeting Agenda

Task 1.2 Critical Project Review (CPR) Meetings

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

CPRs provide the opportunity for frank discussions between the 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 Commission Grants Officer, the Public Interest Energy Research (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 modifications are needed to the tasks, schedule, products, and/or budget for the remainder of the Agreement. Modifications to the Agreement may require a formal amendment (please see the Terms and Conditions). If the Commission Project Manager concludes that satisfactory progress is not being made, this conclusion will be referred to the Energy Commission's Research, Development and Demonstration (RD&D) Policy Committee for its concurrence.

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- 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 this scope of work. The Recipient shall submit 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.

Commission Project Manager Products:

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

Recipient Product:

- CPR Report(s)

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 and objectives 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.

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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

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 days of the end of the reporting period. Attachment A-2, Progress Report Format, provides the recommended specifications.

Product:

- Monthly Progress Reports

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Task 1.5 Final Report

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

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

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

The Recipient shall:

- Prepare an Outline of the Final Report.
- Prepare a Final Report following the approved outline and the latest version of the PIER Final Report guidelines published on the Energy Commission's website 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. Instead of the timeframe listed in the Product Guidelines located in Section 5 of the Terms and Conditions, the Commission Project Manager shall provide written comments on the Draft Final Report within fifteen (15) working days of receipt. 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.

Products:

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

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.

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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 for each task during the term of this Agreement. Match funds must be identified in writing and the associated commitments obtained before the Recipient can incur any costs for which the Recipient will request reimbursement.

The Recipient shall:

- Prepare a letter documenting the match funding committed to this Agreement and submit it to the 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 days if during the course of the Agreement existing match funds are reduced. Reduction in match funds must be approved through a formal amendment to the Agreement and may trigger an additional CPR.

Products:

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

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- Letter that match funds were reduced (if applicable)

Task 1.7 Identify and Obtain Required Permits

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

Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement. Although the PIER budget for this task will be zero dollars, the Recipient shall budget match funds for any expected expenditures associated with obtaining permits. Permits must be identified in writing and obtained before the Recipient can make any expenditures for which a permit is required.

The Recipient shall:

- Prepare a letter documenting the permits required to conduct this Agreement and submit it to the 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 10 days. Either of these events may trigger an additional CPR.

Products:

- Letter documenting the permits or stating that no permits are required
- A copy of each approved permit (if applicable)

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- Updated list of permits as they change during the term of the Agreement (if applicable)
- Updated schedule for acquiring permits as changes occur during the term of the Agreement (if applicable)

TECHNICAL TASKS

TASK 2 PROCESS ANALYSIS AND SYSTEMS DESIGN

The goal of this task is to perform detailed engineering analysis of the entire BBEST system and each component and to arrive at design and operating specifications for the performance of the entire system. Recipient and Sub 1, with ~~burner-related~~ design support from Sub 2, will work together to analyze and engineer all key components of BBEST.

The Recipient shall:

- List desired performance objectives and operational attributes of CHP system.
- List desired burner assembly hardware attributes.
- List desired microturbine attributes.
- Perform process analysis of BBEST using WINSIM Design II software.
- Identify process conditions where BBEST system performance meets project goals
- Design all major BBEST components using available design models from prior CHP-related efforts.
- Design all integration components and assembly for BBEST.
- Review design with team members.
- Prepare a task report that documents, in the required format, BBEST process analysis and design results accomplished under this task, including process specifications, process design drawings, system performance projections and component specifications.

Products:

- List of desired microturbine attributes
- Process Analysis and Systems Design Draft Report
- Process Analysis and Systems Design Final Report

TASK 3 DEMONSTRATION SITE SELECTION AND ACQUISITION

The goal of this task is to identify and acquire a site for the firetube BBEST field tests that will occur in Task 10. Sub 3, a representative of boiler equipment to industry, ~~including the Sub 2 burner~~, will be used to identify viable field test sites and assist Recipient and Sub 1 in acquiring all of the needed agreements and permits required for the site. The site will have a boiler capacity of 10 to 15 Million British Thermal Units (MMBtu) / hr.

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The Recipient shall:

- Identify approximately 3-5 potential sites.
- Sites ranked and list reduced to the best three.
- Select the final site with approval from Commission Project Manager.
- Visit and propose a demonstration test at a facility and negotiate cost of retrofit.
- Negotiate leave-in-place or return to original condition clauses.
- Obtain all necessary agreements and permits for the retrofit and test of the CHP system.
- Draft and execute applicable contracts and indemnification agreements.
- Secure a retrofit and test schedule and host site support.
- Obtain agreements on test duration, site visits, and other factors.
- Draft and sign Field Test Agreement incorporating scope of retrofit and host site support.
- Host facility payments and payment schedules on delivered equipment.
- Prepare a task report that documents, in the required format, the test site definition, ranking and references, and attach all agreements and permits created under this task.

Products:

- Secure host site/Letter of intent
- Complete set of signed contract and agreements
- Demonstration Site Selection and Acquisition Draft Report
- Demonstration Site Selection and Acquisition Final Report

TASK 4 ~~SELECT AND ACQUIRE~~ DESIGN AND BUILD Ultra Reduced NOx Burner (URNB)

The goal of this task is to ~~select and acquire~~ **design and build** the URNB for integration into the firetube BBEST. Recipient will take the lead in this task, with significant support from **Sub 1 and** Sub 2 ~~the burner manufacturer. Sub 2 will provide the URNB at no cost to the project as match funds.~~

The Recipient shall:

- Conclude on final burner design drawings with **Sub 1 and** Sub 2.
- ~~Have Sub 2 fabricate~~ **Lead fabrication of** the burner for BBEST.
- ~~Have Sub 2~~ **Oversee** quality check **of** burner ahead of delivery to Recipient, for installation.
- Prepare all burner documentation, including operating manual.
- Prepare a task report that documents, in the required format, the ultralow NOx burner specifications, and references the operating manual.

Products:

- Assembled burner
- Burner documentation

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- URNB Draft Report
- URNB Final Report

TASK 5 SELECT AND ACQUIRE MICROGASTURBINE

The goal of this task is to select and acquire a Turbo Alternator (TA) - 100kWe SCMTG from ~~Elliot~~ **from GI&E**. ~~As noted above, this SCMTG will be very similar to the engine used in the successful watertube BBEST tests.~~ Sub 1 will assist Recipient in this task and will provide match funds for the SCMTG acquisition under supply agreements in place between Sub 1 and ~~Capstone~~ **GI&E**.

The Recipient shall:

- Conclude on final microturbine specifications with ~~Capstone~~ **GI&E**.
- Have ~~Capstone~~ **GI&E** fabricate the microturbine and test for BBEST.
- Have ~~Capstone~~ **GI&E** quality check and test microturbine ahead of delivery to Recipient, for installation.
- Fabricate new silo combustor and acquire gas compressor.
- Prepare all microturbine documentation, including operating manual.
- Prepare a task report that documents, in the required format, microturbine specifications, and references operating manual.

Products:

- Assembled microturbine
- Microturbine documentation including operating manual
- Microturbine Selection Draft Report
- Microturbine Selection Final Report

TASK 6 FABRICATE INTEGRATION COMPONENTS

The goal of this task is to fabricate the SCMTG/Burner integration component. Recipient will take the lead in this task, with Sub 1 and Sub 2 providing assistance. The integration component that contains the eductor will be fabricated by proven precision manufacturers that have supported Recipient in the past.

The Recipient shall:

- Finalize design drawings for the BBEST integration components.
- Have precision fabricators build the integration components for the test BBEST.
- Quality check the finished components ahead of acceptance at Recipient's site.
- Prepare a task report that documents, component design drawings, fabrication experience, and conclusions on finished components quality.

Products:

- Integration component
- Fabrication Draft Report
- Fabrication Final Report

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TASK 7 SYSTEM ASSEMBLY

The goal of this task is to assemble SCMTG, burner and integration components into a complete package. Recipient will lead the assembly effort in this task. The major components will be assembled to create the package, and all needed insulation added. Controls will then be integrated to support both the SCMTG and burner. Instrumentation, including pressure gages, thermocouples and flow monitoring components will be added and checked out.

The Recipient shall:

- Assemble all BBEST components for unit test installation and testing.
- Add needed insulation.
- Integrate controls.
- Add instrumentation.
- Prepare a task report that documents, in the required format, BBEST integration and instrumentation efforts.
- Prepare CPR Report and attend 1st CPR meeting (as per Task 1.2).

Products:

- Assembled BBEST components
- System Assembly Draft Report
- System Assembly Final Report

TASK 8 PRELIMINARY SYSTEM TESTS

The goal of this task is to perform initial shakedown tests of the firetube BBEST. The system checkout will be performed at the available Recipient test facility and this effort will be led by Recipient. The test boiler will be similar in capacity to the field test site. To monitor emissions, the available Recipient's continuous emissions monitors will be utilized.

The Recipient shall:

- Ready Recipient boiler test facility for testing.
- Install BBEST in test facility.
- Install all needed instrumentation, including continuous emissions monitors.
- Prepare test plan for testing.
- Perform shakedown tests.
- Perform operation tests.
- Prepare test report that shows goals can be met.
- Prepare a task report, which documents, in the required format, test plans, test data and analysis of results.

Products:

- Preliminary Test Plan

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- Preliminary Test Data
- Preliminary System Test Draft Report
- Preliminary System Test Final Report

TASK 9 SITE INSTALLATION AND DEMONSTRATION TEST PLAN

The goal of this effort is to install the firetube BBEST at the field test site and draft a test plan to guide testing. At the initiation of this task, the Recipient with the support of Sub 1 and Sub 2 will create a test plan for the field tests. This will cover startup, low load, high load, normal shutdown and energy shutdown operation. These tests will be followed by operation tests, where the burner and boiler will be modulated with load requirements for the site. Finally, long-term testing will be planned, with regular inspections to note any change of operation or degradation. Simultaneously, with the production of the test plan, Recipient will work together with Sub 1 and the selected boiler/burner installation company (e.g. Bay City Boilers) to install all needed firetube BBEST components at the test site. The test plan will include applicable protocols from Association of State Energy Research & Technology Transfer Institutions (ASERTTI) and local Air District.

The Recipient shall:

- Prepare a field test demonstration plan, containing the following information:
 - Description of host site and energy requirements
 - Description of boiler and burner-CHP system
 - Description of power purchase agreement
 - Test matrix detailing all planned full-load and part-load tests
 - Complete list of measurements:
 - SCMTG power output, kWe
 - Boiler steam load and steam conditions (Pressure and Temperature)
 - Continuous emissions monitoring (O₂, Carbon Dioxide (CO₂), Carbon Monoxide (CO), NO_x) for SCMTG and boiler outlet
 - Fuel use for SCMTG and boiler
 - Burner conditions (temperature, O₂, pressure)
 - FGR and combustion air flowrates
- Ship equipment to site.
- Remove existing burner assembly.
- Install new commercial field CHP-burner assembly unit on a boiler.
- Install power conditioning and hookup.
- Perform preliminary startup and system checkout.
- Prepare a task report that documents, in the required format, the field test plan, including a description of instrumentation to be utilized.
- Prepare CPR Report and attend 2nd CPR meeting (as per Task 1.2).

Products:

- Draft Field Demonstration Test Plan
- Final Field Demonstration Test Plan

Exhibit A WORK STATEMENT

- Installation Draft Report
- Installation Final Report

TASK 10 SYSTEM FIELD TESTING

The goal of this task is to take the fully-functional firetube BBEST assembly through the operational tests to validate the performance goals and commercial readiness as per the test plan. These tests will be performed under the operational requirements specified by ~~Sub 2 and Capstone all commercial equipment~~ **Recipient and GI&E**, and following applicable ASERTTI and Air District testing protocols for boilers and CHP. All needed instrumentation will be installed at the site. Recipient, Sub 1 and Sub 2 will participate in field testing. In support of testing, Southern California Gas (SCG) will assist in measurements and review of results, as a match funds to the project. Tests will be divided between short-term durability testing and long-term durability testing.

The Recipient shall:

- Secure and bring appropriate field test equipment including acoustic, power quality, and fuel flow sensors and emission monitoring to the site.
- Install needed monitors.
- Perform the parametric testing.
- Collect field test data.
- Perform onsite data evaluation.
- Arrange for data collection.
- Perform off-site data analysis of short-term parametric data.
- Collect long-term data remotely.
- Perform selected visits to ensure proper operation.
- Field test report.
- Prepare a recommendation for leaving equipment in place or returning site to original condition using only Altex support.
- Prepare a task report that documents, in the required format, field test results, conclusions and recommendations.

Products:

- Test Data
- Field Test Report
- Operation Recommendation
- System Field Testing Draft Report
- System Field Testing Final Report

TASK 11 SYSTEM PERFORMANCE AND COST EVALUATION AND COMMERCIALIZATION PLAN

The goal of this task is to define and evaluate the performance and costs of firetube BBEST as applied to boiler applications of interest and prepare a commercialization readiness plan. Recipient **Sub 2** will lead this task with the support of Sub 1 and ~~Sub 2~~

Exhibit A WORK STATEMENT

Recipient. Based on the demonstration test results, a conclusion will be reached on the ability of firetube BBEST to achieve product and California Energy Commission goals for the demonstration site.

The Recipient shall:

- Define all field test BBEST performance results.
- Extrapolate performance results to other capacities.
- Define BBEST system and operating costs for several capacities.
- Cost/benefit analysis and lifecycle cost estimates of BBEST and comparison to performance and costs of alternative technologies.
- Prepare a commercialization readiness plan.
- Prepare a task report that documents, in the required format, the BBEST performance and cost evaluation efforts, including a commercialization readiness plan.

Products:

- Performance and Cost Evaluation Results
- Cost/Benefit Analysis
- Commercialization Readiness Plan
- Performance, Cost, and Commercialization Draft Report
- Performance, Cost, and Commercialization Final Report

TASK 12 TECHNOLOGY TRANSFER ACTIVITIES

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

The Recipient shall:

- Prepare a Technology Transfer Plan. The plan shall explain how the knowledge gained in this project will be made available to the public. The level of detail expected is least for research-related projects and highest for demonstration projects. Key elements from this report shall be included in the Final Report for this project.
- Conduct technology transfer activities in accordance with the Technology Transfer Plan. These activities shall be reported in the Monthly Progress Reports.

Products:

- List of technologies transfer activities
- Draft versions of papers for publication
- Final versions of published papers
- Copies of meeting conference agendas, presentations, and reports
- Trip reports on conference(s)/meeting(s) emphasizing value of attendance to the project

Exhibit A WORK STATEMENT

TASK 13 PRODUCTION READINESS PLAN

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

The Recipient shall:

- Prepare a Production Readiness Plan. The degree of detail in the Production Readiness Plan discussion should be proportional to the complexity of producing or commercializing the proposed product and its state of development. The plan shall include, as appropriate, but not be limited to:
 - 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. The product manufacturing effort may include "proof of production processes."
 - A projected "should cost" for the product when in production.
 - The expected investment threshold to launch the commercial product.
 - An implementation plan to ramp up to full production.

Products:

- Draft Production Readiness Plan
- Final Production Readiness Plan