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WORK STATEMENT

TECHNICAL TASK LIST

Task #	CPR	Task Name
1	N/A	Administration
2	X	Optimize Design
3		Establish Power Purchase Agreement (PPA) and Complete Engineering Drawings
4		Manufacture, Install, and Commission the System
5	X	Evaluate System Performance
6		Evaluate System Economics and Market Competitiveness
7		Transfer Technology and Advance Market Engagement
8		Establish Production Readiness

KEY NAME LIST

Task #	Key Personnel	Key Subcontractor(s)	Key Partner(s)
1	Scott Samuelsen		
2	Scott Samuelsen Jack Brouwer Tony Leo Masahiro Ishimatsu Fabian Mueller	FuelCell Energy Yazaki	
3	Scott Samuelsen Jack Brouwer		UCI Facilities Management
4	Scott Samuelsen	FuelCell Energy Yazaki	UCI Facilities Management TPP
5	Scott Samuelsen Jacob Brouwer Fabian Mueller		
6	Scott Samuelsen Lori Schell	Empowered Energy	
7	Scott Samuelsen Bill Tomlinson		
8	Scott Samuelsen Tony Leo Masahiro Ishimatsu	FuelCell Energy Yazaki	

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GLOSSARY

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

Term/ Acronym	Definition
AHU	Air Handling Unit
ASERTTI	Association of State Energy Research and Technology Transfer Institutions
BTU	British Thermal Unit
CaSFCC	California Stationary Fuel Cell Collaborative
CCHP	Combined Cooling, Heat, and Power
CPR	Critical Project Review
COE	Cost-of-Electricity
DG	Distributed Generation
DG-CCHP	Distributed Generation with Combined Cooling, Heat, and Power
DOE	Department of Energy
EPAG	Environmentally Preferred Advanced Generation
FCE	FuelCell Energy, Inc.
HTFC	High-temperature Fuel Cell
HTFC-chiller	High-Temperature Fuel Cell/absorption chiller
kW	kilowatts
MCFC	Molten Carbonate Fuel Cell
MW	megawatts
NFCRC	National Fuel Cell Research Center
PIER	Public Interest Energy Research
PPA	Power Purchase Agreement
PRAC	Pacific Region Combined Heat and Power Application Center
RD&D	Research Development and Demonstration
RT	Refrigeration Tons
SOFC	Solid Oxide Fuel Cell
TPP	Third-Party Provider
TES	Thermal Energy Storage
UCI	University of California, Irvine

Problem Statement:

High-temperature fuel cell/absorption chiller combined cooling, heating, and power (CCHP) systems offer the potential to generate ultra-clean, high-efficiency distributed power with virtually zero criteria pollutant emissions and effectively utilize waste heat to provide cooling. In particular, the high quality heat from high-temperature fuel cells can be recovered through absorption chilling and thereby (1) displace electricity required today for chillers, (2) dramatically reduce the emission of criteria pollutants and greenhouse gases, (3) increase reliability for the customer, and (4) reduce the demand for additional transmission and distribution circuits. Such integrated systems are not yet commercially available and have not been previously demonstrated in California. As a result, there is a need for a systematically designed initiative to develop, demonstrate,

and showcase the system. This agreement will develop and demonstrate the technology in a commercial building design within a large institution and thereby provide visibility and serve to critically evaluate the commercial viability of the technology.

Goals of the Agreement:
The goal of this Agreement is to proactively accelerate the deployment of high temperature fuel cell (HTFC)-chiller technology into the California market.

Objectives of the Agreement:
The objectives of this Agreement are established to meet the project goal:

1. Project Administration
2. Optimize Design
3. Establish Power Purchase Agreement (PPA) and Complete Engineering Drawings
4. Manufacture, Install, and Commission the System
5. Evaluate System Performance
6. Evaluate System Economics and Market Competitiveness
7. Transfer Technology and Advance Market Engagement
8. Establish Production Readiness

Each objective is represented as a specific task for the project.

The proposed project meets the Public Interest Energy Research (PIER) goal of rate-payer benefit by (1) reducing the environmental impacts of electricity generation, distribution and use, (2) enhancing California's economy through technology advancement, employment and education, (3) reducing the cost-of-electricity (COE), and (4) increasing the reliability and power quality of electricity.

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.

Recipient Products:

- Updated Schedule of Products (no draft)
- Updated List of Match Funds (no draft)
- Updated List of Permits (no draft)

Commission Project Manager Product:

- Kick-Off Meeting Agenda (no draft)

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 if necessary, the budget will be reallocated to cover the additional costs borne by the Recipient, but the overall grant amount will not increase.

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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.
- 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 (no draft)
- Schedule for written determination (no draft)
- Written determination (no draft)

Recipient Product:

- CPR Report(s) (no draft)

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.

  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 (no draft)
- Schedule for completing closeout activities (no draft)

Task 1.4 Quarterly 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 Quarterly 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. The recommended specifications for each progress report are contained in Exhibit A, Attachment A-2.

Product:

- Quarterly Progress Reports (no draft)

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

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 the 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~~. Unless an exception is approved by the Commission Contract Manager in writing, 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:

- Unless an exception is approved by the Commission Contract Manager in writing, 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 funs were a part of the proposal that led to the Energy Commission warding 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 mach funds will be applied. If the in-kind contribution is equipment o 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
- 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 (no draft)
- Copy(ies) of each match fund commitment letter(s) (if applicable) (no draft)
- Letter(s) for new match funds (if applicable) (no draft)
- Letter that match funds were reduced (if applicable) (no draft)

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 reimbursable under this Agreement. Permits must be identified in writing before the Recipient can incur any costs related to the use of the permit(s) 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 10 days. Either of these events may trigger an additional CPR.

Products:

- Letter documenting the permits or stating that no permits are required (no draft)
- A copy of each approved permit (if applicable) (no draft)
- Updated list of permits as they change during the term of the Agreement (if applicable) (no draft)
- Updated schedule for acquiring permits as changes occur during the term of the Agreement (if applicable) (no draft)

TECHNICAL TASKS

TASK 2. Optimize Design

The goal of this task is to design and optimize the high-temperature fuel cell/absorption chiller CCHP system.

The Recipient shall:

- Formally characterize the cooling and heating demand of the building.
- Develop a dynamic model of the system including thermodynamic Aspen® compatible models and dynamic Simulink® model
- Conduct dynamic simulation and evaluate the system heat and cooling compared to the building needs.
- Conduct a detailed system design and optimization analysis with an emphasis on:
  - Overall efficiency
  - Required energy storage and means of energy storage
  - Stack degradation rate
  - Water consumption
  - Backpressure fluctuations
  - Overall economics
  - Chiller life

- Develop an appropriate system operating flexibility test plan utilizing developed dynamic modeling and building data resources.
- Develop an appropriate optimization testing plan utilizing developed system analysis resources.
- Finalize the optimized design of the system to be manufactured
- Recipient shall participate in a CPR per Task 1.2

Products:

- System Optimization Methodology (no daft)
- Notification of Dynamic System Model Completion (no draft)
- Draft dynamic Model and Simulation Report
- Final dynamic Model and Simulation Report
- System Flexibility Test Plan (no draft)
- Optimization Test Plan (no draft)
- Optimized System Design Report (no draft)

TASK 3. Establish Power Purchase Agreement and Complete Engineering Drawings

The goal of this task is to finalize the installation design and establish a power purchase agreement between the University of California, Irvine and a third party distributor.

The Recipient shall:

- Establish a power purchase agreement between the University of California, Irvine and a third-party distributor.
- Finalize the installation design

Products:

- Copy of Power Purchase Agreement (no draft)
- Draft Report of Installation Design
- Final Report of Installation Design

TASK 4. Manufacture, Install, and Commission the System

The goal of this task is to build, install, commission, and demonstrate the system.

The Recipient shall:

- Manufacture the system components including:

  - Modified FuelCell Energy DFC300MA
  - Modified Yazaki CH-KE4040
  - Balance-of-plant components
- Ensure effective preparation of the site
- Ensure installation of the integrated system
- Ensure proper commissioning of the system
- Provide a report to include, but not be limited to, build, installation, and commissioning of the system

Products:

- Photographs of completed installation
- Report of the Build, Installation, and Commissioning (no draft)

TASK 5. Evaluate System Performance

The goal of this task is to evaluate the system through (1) expansive monitoring, (2) analysis of performance and operating data, and (3) application of thermodynamic and dynamic system models to evaluate and advance the system performance.

The Recipient shall:

- Acquire time-resolved measurements of the system concurrent with the "Distributed Generation and Combined Heat and Power Field Testing Protocol" developed for Association of State Energy Research and Technology Transfer Institutions (ASSERTTI).
- Develop plots that show the amount of waste-heat recovery versus time and overall electrical and thermal efficiency.
- Evaluate the system ability to simultaneously meet real electrical, cooling and heating load demands in building and institutional operating modes.
- Test the equipment after 1 year and after 2 year of the operation to abide by the ASERTTI long-term monitoring protocol.
- Utilize the thermodynamic and dynamic models developed in Task 2 to (1) ascertain model performance against measured data, (2) fully characterize the performance of the HTFC-chiller product for commercial application, and (3) establish the operation conditions for minimizing the COE and maximizing reliability for the customer.
- Recipient shall participate in a CPR per Task 1.2

Products:

- Draft Data Acquisition Report
- Final Data Acquisition Report
- Draft ASERTTI Field Test Report

- Final ASERTTI Field Test Report
- Draft ASERTTI Long-Term Monitoring report
- Final ASERTTI Long-Term Monitoring report
- Draft Thermodynamic Analysis Report
- Final Thermodynamic Analysis Report

TASK 6. Evaluate System Economics and Market Competitiveness

The goal of this task is to evaluate the economic and market competitiveness of HTFC-chiller CCHP systems in California.

The Recipient shall:

- Develop an appropriate system economic analysis plan
- Evaluate the installed and operating economic cost of the installation
- Evaluate potential system economic cost reduction through increased deployment
- Develop an appropriate market competiveness analysis plan
- Calculate the system operating cost of electricity and market potential
- Compare the system cost of electricity and market potential compared to other competing technologies in today's energy infrastructure as well as projected future grid scenarios.

Products:

- System Economic Analysis Plan (no draft)
- Draft Economic Analysis Report
- Final Economic Analysis Report
- System Market Analysis Plan (no draft)
- Draft Market Analysis Report
- Final Market Analysis Report

TASK 7. Transfer Technology and Advance Market Engagement

The goal of this task is to develop a plan to convey the real-time system operation as well as results and lessons learned to the market, the public as a whole, and key decision-makers.

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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 Quarterly Progress Reports.
- Develop web-based set of information for technology transfer linked to the Pacific Region Combined Heat and Power Application Center (PRAC), National Fuel Cell Research Center (NFCRC), and the California Stationary Fuel Cell Collaborative (CaSFCC). The set of information shall include the real-time operation, results and lessons, and other information as appropriate.

Comment [c1]: Add detailed description of what The Technology Transfer Link

Products:

- Draft Technology Transfer Plan
- Final Technology Transfer Plan
- Web-Based Technology Transfer linked to the PRAC, NFCRC, and CaSFCC Sites

TASK 8. Establish Production Readiness

The goal of this task is to determine the steps that will lead to the competitive commercialization of HTFC-chiller technology in California.

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, 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 along with a tabulation of current cost and relevant performance measures on the date of proposal submittal, at the end of the project, and at the time of market introduction, with a date specified.

- 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