STATE OF CALIFORNIA

CONTRACT REQUESTS FORM (CRF)

CEC-94 (Revised 5/11) CALIFORNIA ENERGY COMMISSION

☐ New Contract _____ ☒ Amendment to Existing Contract: 500-08-042 Amendment Number: 2

Division	Contract Manager:	MS-	Phone	CM Training Date
Energy Research and Development	Golam Kibrya	51	916-327-1625	9/14/2005

Contractor's Legal Name	Federal ID Number
The Regents of the University of California, Davis-Western Cooling Efficiency Center	94-6036494

Title of Project
Western Cooling Efficiency Center Research

Term	Start Date	End Date	Amount
New/Original Contract	6/22/2009	12/1/2012	$ 2,100,000

Line up the Amendment information as best as possible within the following table.

Amendment #	End Date *(mm/dd/yy)*	Amount
Amendment 1	3/31/2013	$0
Amendment 2	3/13/2015	$800,000

Business Meeting Information			
Proposed Business Meeting Date	5/9/2012	☐ Consent	☒ Discussion
Business Meeting Presenter	Golam Kibrya	Time Needed:	5 minutes

Agenda Item Subject and Description

Possible approval of Amendment #2 to Contract 500-08-042 with the UC Davis Western Cooling Efficiency Center to add $800,000 and extend the term 23 months for research projects in the areas of automated building sealing, ground source heat pumps, hydronic heating systems, and water re-use. The terms and conditions are also being modified as directed by DGS. Contact: Golam Kibrya (PIER electricity and natural gas funding)

Business Meeting approval is not required for the following types of contracts: *Executive Director's signature is required in all cases.*

☐ Contracts less than $10k *(Policy Committee's signature is also required)*

☐ Amendment for a no-cost time extension. Must be first extension, less than one year and original contract less than $100k.

☐ Contracts less than $25k for Expert Witness in Energy Facility licensing cases and amendments.

Purpose of Contract or Purpose of Amendment, if applicable

The purpose of this amendment is to increase funding by an additional $800,000 and extend the contract term another 23 months. This amendment expands the scope of work and allows more time for the following four tasks: 1) Develop and test an innovative and practical envelope sealing solution, 2) Develop encapsulated phase-change materials in hydronic heating and cooling, 3) Test the practicality of an innovative installation method for geothermal heating systems, and 4) Develop and test systems for purifying and reusing gray water for use in evaporative cooling systems.

As directed by DGS, Office of Legal Services, the Exhibit D, Special Terms and Conditions, Disputes Provision is being amended to remove the Binding Arbitration language. In addition, other edits are being made to the remaining language.

California Environmental Quality Act (CEQA) Compliance

1. Is Contract considered a "Project" under CEQA?
   ☒ Yes: skip to question 2 ☐ No: complete the following (PRC 21065 and 14 CCR 15378):
   Explain why contract is not considered a "Project":

2. If contract is considered a "Project" under CEQA:
   ☒ a) Contract **IS** exempt. (Draft NOE required)
   ☐ Statutory Exemption. List PRC and/or CCR section number:
   ☒ Categorical Exemption. List CCR section number: 14 CCR 15306
   ☐ Common Sense Exemption. 14 CCR 15061 (b) (3)
   Explain reason why contract is exempt under the above section:
   Class 6 - Basic data collection, research, experimental management, and resource evaluation activities that do not result in major disturbances to an environmental resource.
   ☐ b) Contract **IS NOT** exempt. The Contract Manager needs to consult with the Energy Commission attorney assigned to their division and the Siting Office regarding a possible Initial Study.

Budgets Information

Contract Amount Funded		Breakdown by FY			Funding Sources			
Funding Source	Amount	FY	Amount	Approved?	Funding Source	FY	Budget List No.	Amount
ARFVTF	$	11-12	$800,000	Yes	PIER-E	10-11	501.027I	$229,100
ECAA	$		$		NG Subaccount, PIERDD	10-11	501.001E	$300,000
State- ERPA	$		$		PIER-E	11-12	501.027J	$270,900
Federal	$		$					$
PIER - E	$500,000		$					$
PIER - NG	$300,000		$					$
Reimbursement	$		$					$
Other	$		$					$
TOTAL:	$800,000	TOTAL:	$800,000				TOTAL:	$800,000
Reimbursement Contract #:					Federal Agreement			

Contractor's Administrator/ Officer		Contractor's Project Manager	
Name:	Paula Noble	Name:	Mark Modera
Address:	1850 Research Park Dr Rm 170	Address:	1850 Research Park Dr Rm 170
City, State, Zip:	Davis, CA 95618-6153	City, State, Zip:	Davis, CA 95618-6153
Phone/ Fax:	530-747-3921 / 530-747-3929	Phone/ Fax:	530-754-7671 /
E-Mail:	PNoble@ucdavis.edu	E-Mail:	

Contractor Is

☐ Private Company *(including non-profits)*
☒ CA State Agency *(including UC and CSU)*
☐ Government Entity *(i.e. city, county, federal government, air/water/school district, joint power authorities, university from another state)*

Selection Process Used

☐ Solicitation Select Type Solicitation #: _____ # of Bids: _____ Low Bid? ☐ No ☐ Yes
☐ Non Competitive Bid *(Attach CEC 96)*
☒ Exempt Interagency

Civil Service Considerations

☐ Not Applicable (Contract is with a CA State Entity or a membership/co-sponsorship)
☒ Public Resources Code 25620, et seq., authorizes the Commission to contract for the subject work. (PIER)

☐ The Services Contracted:
- ☐ are not available within civil service
- ☐ cannot be performed satisfactorily by civil service employees
- ☐ are of such a highly specialized or technical nature that the expert knowledge, expertise, and ability are not available through the civil service system.

☐ The Services are of such an:
- ☐ urgent
- ☐ temporary, or
- ☐ occasional nature

that the delay to implement under civil service would frustrate their very purpose.

Justification:
Public Resources Code 25620, et seq., authorizes the Commission to contract for the subject work. (PIER)

Payment Method

☒ A. Reimbursement in arrears based on:
☒ Itemized Monthly ☐ Itemized Quarterly ☐ Flat Rate ☐ One-time
☐ B. Advanced Payment
☐ C. Other, explain:

Retention

1. Is contract subject to retention?	☒ No	☐ Yes
If Yes, Do you plan to release retention prior to contract termination?	☐ No	☐ Yes

Justification of Rates

Rates reasonable considering the qualifications of the staff and are consistent with prior contracts with this research entity and comparable research entities.

Disabled Veteran Business Enterprise Program (DVBE)

1. ☒ Not Applicable
2. ☐ Meets DVBE Requirements DVBE Amount:$ _____ DVBE %: _____
   - ☐ Contractor is Certified DVBE
   - ☐ Contractor is Subcontracting with a DVBE: _____
3. ☐ Requesting DVBE Exemption (attach CEC 95)

Is Contractor a certified Small Business (SB), Micro Business (MB) or DVBE?	☒ No	☐ Yes
If yes, check appropriate box:	☐ SB ☐ MB ☐ DVBE	

Is Contractor subcontracting any services?	☒ No	☐ Yes
If yes, give company name and identify if they are a Small Business (SB), Micro Business (MB) and/or DVBE:		
	☐ No	☐ SB ☐ MB ☐ DVBE
	☐ No	☐ SB ☐ MB ☐ DVBE
	☐ No	☐ SB ☐ MB ☐ DVBE
	☐ No	☐ SB ☐ MB ☐ DVBE
	☐ No	☐ SB ☐ MB ☐ DVBE
	☐ No	☐ SB ☐ MB ☐ DVBE
	☐ No	☐ SB ☐ MB ☐ DVBE
	☐ No	☐ SB ☐ MB ☐ DVBE
	☐ No	☐ SB ☐ MB ☐ DVBE
	☐ No	☐ SB ☐ MB ☐ DVBE

Miscellaneous Contract Information		
1. Will there be Work Authorizations?	☒ No	☐ Yes
2. Is the Contractor providing confidential information?	☒ No	☐ Yes
3. Is the contractor going to purchase equipment?	☒ No	☐ Yes
4. Check frequency of progress reports ☐ Monthly ☒ Quarterly ☐		
5. Will a final report be required?	☐ No	☒ Yes
6. Is the contract, with amendments, longer than a year? If yes, why?	☐ No	☒ Yes
The Department of General Services has agreed to give the Commission blanket authority to execute multi-year contracts to support the Commission's RD&D Programs.		

The following items should be attached to this CRF		
1. Scope of Work, Attach as Exhibit A.	☐ N/A	☒ Attached
2. Budget Detail, Attach as Exhibit B.	☐ N/A	☒ Attached
3. CEC 96, NCB Request	☒ N/A	☐ Attached
4. CEC 30, Survey of Prior Work	☒ N/A	☐ Attached
5. CEC 95, DVBE Exemption Request	☒ N/A	☐ Attached
6. Draft CEQA Notice of Exemption (NOE)	☐ N/A	☒ Attached
7. Resumes	☐ N/A	☐ Attached
8. CEC 105, Questionnaire for Identifying Conflicts		☒ Attached
9. CEC 106, IT Component Reporting Form		☒ Attached

Contract Manager	Date	Office Manager	Date	Deputy Director	Date

The following signatures are only required when contract approval is delegated to the Executive Office and not approved at a Business Meeting. See Business Meeting Information Section.

Presiding Policy Committee	Date	Associate Policy Committee	Date	Executive Director	Date

Exhibit A

SCOPE OF WORK

TECHNICAL TASK LIST

Task #	CPR	Task Name
1		Administration
2	X	Technology Research and Development
3	X	Industry Application of Advanced Cooling Technologies

KEY NAME LIST

Task #	Key Personnel	Key Subcontractor(s)	Key Partner(s)
1	Mark Modera		
2	Mark Modera		WCEC Affiliates
3	Mark Modera		WCEC Affiliates

GLOSSARY

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

Acronym	Definition
AC	Air Conditioning
ARC	Annual Report on Cooling
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
Energy Commission	California Energy Commission
CLTC	California Lighting Technology Center
CPR	Critical Project Review
CWS	Chilled Water Storage
DOE	United States Department of Energy
HVAC	Heating Ventilation and Air Conditioning
MS	Microsoft
OHCS	Optimized Hybrid Cooling System
PAC	Project Advisory Committee
PCM	Phase Change Material
PIER	Public-Interest Energy Research
PV	Photovoltaic
R&D	Research and Development
REA	Retail Energy Alliance
RTU	Rooftop Air Conditioning Unit

Acronym	Definition
SCE	Southern California Edison
T20	Title 20
T24	Title 24
UCC.1	Uniform Commercial Code (Financing Statement)
WCC	Western Cooling Challenge
WCEC	UC Davis Western Cooling Efficiency Center
ZPC	Zero Peak Cooling

Problem Statement

High growth rates in California's hot climate areas are increasing cooling-related energy demand and consumption. Conventional building practice overlooks integrated design opportunities, utilizes cooling equipment poorly suited to a dry climate, and defensively over sizes cooling equipment, all of which decrease energy efficiency. Many buildings create large, cooling-related afternoon "load spikes" that cumulatively result in utility electric load peaks. Although there are large diurnal (day-night) temperature swings in many of these climate areas, and night ventilation was formerly a standard practice to mitigate daytime heat, few buildings now make use of the opportunities for electric load reduction and energy savings that these swings create.

California has the potential to dramatically reduce both peak cooling electricity demand and cooling energy use by using the natural advantages of its relatively dry climate. Dehumidification, critically important in the steamier eastern parts of the country, is an unneeded waste of energy in a dry climate. Even conventional vapor-compression equipment that has been optimized for hot dry conditions can reduce peak cooling loads and energy use in California by over 15%.

Active use of evaporative cooling, problematic in the east, can yield great benefits in the arid west. For example, indirect evaporative cooling of the ventilation air on a Rooftop Packaged Unit (RTU) can reduce its peak afternoon cooling electricity demand by 10%, and its annual cooling energy use by 20%, without adding moisture to that ventilation air. Evaporatively cooling a vapor-compression condenser can reduce its peak electricity demand by 20-25%, and its annual cooling energy use by 10-15%, once again without increasing indoor humidity levels. Using water rather than forced-air as a primary thermal distribution medium reduces fan energy and eliminates most duct leakage issues, potentially reducing cooling energy by an additional 25%. These savings can be augmented even further by using radiant cooling, which, because of its large surface area, can utilize warmer water temperatures, thereby increasing the efficiency of cooling equipment, and increasing the fraction of cooling that can be performed by evaporation and/or night-sky radiation.

Concrete slabs offer major opportunities for storing cooling at night, and can be coupled with a variety of natural cooling sources that can discharge heat to the night environment, including natural ventilation and evaporatively chilled water. Night ventilation, chilled water storage, multi-stage evaporative cooling, and low-energy cooling delivery strategies all offer savings opportunities that make zero-net-energy buildings an achievable goal in California. In addition, for certain applications and California climates/regions, ground source heat pumps are an attractive means for reducing both peak demand and energy use.

While these techniques have the potential to greatly reduce electricity demand and consumption, they are seldom considered for mainstream building projects. Large manufacturers of air conditioning equipment promote and market standard boxed solutions across the nation, and resist climate-based standards that would reduce their economies of scale, even at the expense of efficiency and life-cycle cost. Engineering and technical training curricula largely suffer from the same problem, leaving most designers, contractors and technicians without adequate knowledge of alternatives. Only those few individuals with a natural fascination for energy efficiency have pursued the alternatives, and impressive demonstrations of the potential of low energy cooling techniques have attracted little sustained attention. The issue of climate change is serving to focus more attention on cooling energy demand and consumption, but cooling strategies and technologies optimized for California climates continue to face barriers in technical, market, and environmental categories, as outlined below:

Technical barriers:

- Designers, installers, and maintenance staff have often not been well informed about the specific applications, requirements, and maintenance needs for traditional evaporative coolers. This has ultimately led to dissatisfaction with their performance.
- Water maintenance can be challenging when dissolved solids are present; and even without hardness minerals, wet environments can lead to corrosion of metallic components. Additional research and engineering is needed to identify and qualify the best water management strategies for the complete range of evaporative cooling systems and supply water conditions.
- Climate-optimized conventional Air Conditioning (AC) equipment, which offers meaningful efficiency gains through selection of the most appropriate components, has been stymied by national standards that inaccurately predict the efficiency of that equipment in hot, dry climates.
- Proper selection and installation of AC equipment is little understood or appreciated by either building owners or contractors, leading to poor quality, marginally less-expensive installations that waste energy through duct leakage, duct conduction, poor airflow, over-sized equipment, improper refrigerant charge, malfunctioning economizers, and other causes.
- Radiant cooling is rarely used in the United States, in part because of fears of surface condensation. Although the likelihood of this problem is minimal when using higher-temperature cooling sources in dry climates, radiant cooling and associated ventilation strategies have received relatively little attention from national engineering societies and are generally poorly understood in the United States market.

- Ground source heat pumps are typically expensive to install, principally due to the cost and regional variability associated with installing the ground loop.

Market barriers:

- The mature, mass-production market efficiently delivers forced-air vapor-compression air conditioners designed for a national market, but which perform sub-optimally in hot, dry climates. California engineers and their customers seldom consider more efficient alternatives or even realize that such alternatives exist.
- Small companies entering the market with more advanced evaporative-equipment designs are often under-capitalized, making it difficult to perfect their products or adequately develop manufacturing and quality control processes. Larger companies have been reluctant to adopt region-specific design changes or more advanced evaporative techniques.
- Split incentives are caused whenever owners do not pay for electricity and gas consumption in their buildings. Despite the fact that the tenant would like to pay lower energy bills, the Heating Ventilation and Air Conditioning (HVAC) equipment in their building is generally selected by the owner on the basis of minimum code requirements and first cost. Moreover, owners are generally not interested in straying from the mainstream, for fear of unfamiliarity impacting future sales transactions. Owner-occupied buildings can also experience a split incentive due to organizational structures wherein equipment purchase costs are paid through a facilities department, while operating costs are the responsibility of the operations and maintenance department. Even when these split incentives are overcome, 3- to 5-year simple payback requirements are more common than Life Cycle Cost analyses.

Environmental barriers:

- Water-based cooling technologies require a balance of the need to reduce energy and peak demand against the need to conserve water. The California Energy Commission is not supportive of technologies that will increase on-site water use. Because of their significant benefits in energy and peak demand, and even their likely benefits in reducing water consumed at the power plant, however, they are worth pursuing. Any development of these technologies requires an integrated consideration of energy and water efficiency, and methods to minimize the water used by these systems must be provided. All of the activities undertaken by the UC Davis Western Cooling Efficiency Center (WCEC) will adhere to these principles.
- Water containing solids concentrated by evaporation must be discharged periodically to maintain equipment function. Toxic anti-oxidants and biocides are often added to large-system cooling water as well, though non-chemical water treatment options exist. Requirements for disposal of discharge water vary by jurisdiction; such variability causes additional costs for the evaporative cooling industry. Disposing of water by directing it onto landscaping can improve the water equation, but additional research is needed to verify that plants are not endangered by flushed water from evaporative cooling equipment.

- A study of water issues as barriers to advanced cooling systems must also present convincing evidence that properly-maintained (or even inadequately maintained) systems do not produce environmental health threats such as mold, mildew, legionnaire's disease, etc.
- Ventilation can be an efficient means of cooling, but dust and allergens can be introduced by ventilation, and open windows can be a noise source and a security concern. Effective ventilation and filtration strategies that do not compromise occupant security, health and comfort are needed.

Strategy:

The WCEC will identify, investigate and support cooling technologies that can significantly impact cooling electricity demand and energy consumption in California. The technologies within the scope of the WCEC include: suitable applications for various types of evaporative cooling, technologies that make use of diurnal temperature variations to reduce the cooling electricity demand and energy use, technologies that reduce energy consumption for distributing cooling in California buildings (e.g. energy efficient fans/motors, water vs. air thermal distribution, energy-efficient equipment/distribution-system combinations), innovative new cooling technologies, and in certain instances, technologies that reduce cooling loads.

The WCEC will address the identified barriers to implementing the technologies under consideration. Some examples of the types of activities to be pursued include: organization and assessment of existing information on water chemistry and management techniques to guide further research and product developments, competitions for advanced cooling technologies suited to California, and participation in codes and standards processes to support advanced cooling technologies. In addition, firms developing and marketing alternative, evaporative cooling systems will be assisted with technical and market issues. End users, equipment suppliers, and electric utilities will be connected and informed through the affiliates programs of the WCEC. Through these activities successful business conditions will be identified and created to promote the adoption of efficient, climate-adapted cooling systems in California.

Goals of the Agreement

The overall goals of this agreement are to reduce greenhouse gas emissions, as stated in the California Global Warming Solutions Act of 2006 (AB-32), by reducing the energy required to provide comfortable thermal environments in buildings, and to address the goals of the California Reliable Electric Service Investments Act (SB-1250) by reducing peak loads related to cooling buildings, thereby increasing the sufficiency and reliability of the entire electric system.

Further goals are to enhance indoor environments by providing more comfortable temperature control and healthful ventilation, to improve the natural environment by reducing demands on it related to generating and distributing electricity and natural gas, and to improve the California economy by providing more affordable indoor comfort systems and by providing local jobs and supporting local industries.

The WCEC will meet these goals by:

- providing needed assistance to the cooling industry at every level of development, from early engineering studies, to field demonstrations, to training of installers and end users;

- supporting utility efficiency programs by suggesting, guiding, coordinating and evaluating emerging technology demonstrations;
- helping manufacturers and contractors to understand utility programs;
- serving as a clearinghouse for western-climate cooling information; and
- supporting policy makers by providing information and insight into potential benefits and strategies for developing and promoting more efficient indoor environmental control equipment.

Objectives of the Agreement

The specific and measurable objectives of this Agreement are to:

- Identify and address engineering gaps in advanced cooling systems and equipment;
- Assist industry in developing cooling systems with superior performance;
- Coordinate with other research institutions and industry partners to leverage their contributions;
- Conduct field tests of advanced cooling technologies to assess performance;
- Conduct research to support advanced cooling technologies and strategies, including external as well as internal advancements;
- Identify and address barriers that are keeping advanced cooling technologies from being successful in the market;
- Provide simulation and design tools needed to implement advanced cooling technologies;
- Participate in development or support for codes and standards related to efficient cooling;
- Disseminate information on advanced cooling systems through contact with university and extension students, workshops, a website, and other mechanisms.

Completion of these objectives in coordination with affiliates and the WCEC steering committee will accelerate diffusion of practical, ultra-efficient cooling technologies into the California marketplace.

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 Contractor shall:

- Attend a “kick-off” meeting with the Commission Contract Manager, the Contracts Officer, and a representative of the Accounting Office. The Contractor shall bring their Project Manager, Contracts Administrator, Accounting Officer, and others designated by the Commission Contract 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 Contract 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:

- Terms and conditions of the Agreement
- CPRs (Task 1.2)
- Match fund documentation (Task 1.7)
- Permit documentation (Task 1.8)

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

- The Commission Contract Manager's expectations for accomplishing tasks described in the Scope of Work;
- An updated Schedule of Deliverables
- Progress Reports (Task 1.4)
- Technical Deliverables (Task 1.5)
- Final Report (Task 1.6)
- Establish the PAC (Task 1.10)
- PAC Meetings (Task 1.11)

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

Contractor Deliverables:

- An Updated Schedule of Deliverables
- An Updated List of Match Funds
- An Updated List of Permits
- Schedule for Recruiting PAC Members

Commission Contract Manager Deliverables:

- Final Report Instructions

Task 1.2 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 it should, are there any modifications that need to be made to the tasks, deliverables, schedule or budget.

CPRs provide the opportunity for frank discussions between the Energy Commission and the Contractor. CPRs generally take place at key, predetermined points in the Agreement, as determined by the Commission Contract Manager and as shown in the Technical Task List above and in the Schedule of Deliverables. However, the Commission Contract Manager may schedule additional CPRs as necessary, and, if necessary, the budget will be reallocated to cover the additional costs borne by the Contractor, but the overall contract amount will not increase.

Participants include the Commission Contract Manager and the Contractor, and may include the Commission Contracts Officer, the PIER Program Team Lead, other Energy Commission staff and Management as well as other individuals selected by the Commission Contract Manager to provide support to the Energy Commission.

The Commission Contract Manager shall:

- Determine the location, date and time of each CPR meeting with the Contractor. These meetings generally take place at the Energy Commission, but they may take place at another location.
- Send the Contractor 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, deliverables and budget for the remainder of the Agreement, including not proceeding with one or more tasks. If the Commission Contract Manager concludes that the project needs a formal amendment or that satisfactory progress is not being made and the project needs to be ended, these conclusions will be referred to the Commission's Research, Development and Demonstration Policy Committee for its concurrence.
- Provide the Contractor with a written determination in accordance with the schedule. The written response may include a requirement for the Contractor to revise one or more deliverable(s) that were included in the CPR.

The Contractor 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 deliverables identified in this Scope of Work. Submit these documents to the Commission Contract 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.

Contractor Deliverables:

- CPR Report(s)
- CPR deliverables identified in the Scope of Work

Commission Contract Manager Deliverables:

- Agenda and a List of Expected Participants
- Schedule for Written Determination
- Written Determination

Task 1.3 Final Meeting

The goal of this task is to closeout this Agreement.

The Contractor shall:

- Meet with the Energy Commission 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 Contractor, the Commission Contracts Officer, and the Commission Contract 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 Contract Manager.

The technical portion of the meeting shall present findings, conclusions, and recommended next steps (if any) for the Agreement. The Commission Contract Manager will determine the appropriate meeting participants.

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

- What to do with any state-owned equipment (Options)
- Need to file UCC.1 form re: Energy Commission's interest in patented technology
- Energy Commission's request for specific "generated" data (not already provided in Agreement deliverables)
- Need to document Contractor's disclosure of "subject inventions" developed under the Agreement
- "Surviving" Agreement provisions, such as repayment provisions and confidential deliverables
- Final invoicing and release of retention

- Prepare a schedule for completing the closeout activities for this Agreement.

Deliverables:

- Written documentation of meeting agreements and all pertinent information
- Schedule for completing closeout activities

REPORTING

See Exhibit D, Reports/Deliverables/Records.

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.

The Contractor shall:

- Prepare progress reports which summarize all Agreement activities conducted by the Contractor 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 Contract Manager within 10 working days after the end of the reporting period. Attachment A-2, Progress Report Format, provides the recommended specifications.

Deliverables:

- Quarterly Progress Reports

Task 1.5 Test Plans, Technical Reports and Interim Deliverables

The goal of this task is to set forth the general requirements for submitting test plans, technical reports and other interim deliverables, unless described differently in the Technical Tasks. When creating these deliverables, the Contractor shall use and follow, unless otherwise instructed in writing by the Commission Contract Manager, the latest version of the PIER Style Manual published on the Energy Commission's web site:

http://www.energy.ca.gov/contracts/pier/contractors/index.html

The Contractor shall:

- Unless otherwise directed in this Scope of Work, submit a draft of each deliverable listed in the Technical Tasks to the Commission Contract Manager for review and comment in accordance with the approved Schedule of Deliverables. The Commission Contract Manager will provide written comments back to the Contractor on the draft deliverable within 10 working days of receipt. Once agreement has been reached on the draft, the Contractor shall submit the final deliverable to the Commission Contract Manager. The Commission Contract Manager shall provide written approval of the final deliverable within 10 working days of receipt. Key elements from this deliverable shall be included in the Final Report for this project.

Task 1.6 Final Report

The goal of this task is to prepare a comprehensive written Final Report that describes the original purpose, approach, results and conclusions of the work done under this Agreement. The Commission Contract Manager will review and approve the Final Report. The Final Report must be completed on or before the termination date of the Agreement. When creating these deliverables, the Contractor shall use and follow, unless otherwise instructed in writing by the Commission Contract Manager, the latest version of the PIER Style Manual published on the Energy Commission's web site:

http://www.energy.ca.gov/contracts/pier/contractors/index.html

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

Task 1.6.1 Final Report Outline

The Contractor shall:

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

Deliverables:

- Draft Outline of the Final Report

- Final Outline of the Final Report

Task 1.6.2 Final Report

The Contractor shall:

- Prepare the draft Final Report for this Agreement in accordance with the approved outline.
- Submit the draft Final Report to the Commission Contract Manager for review and comment. The Commission Contract Manager will provide written comments within 10 working days of receipt.

  Once agreement on the draft Final Report has been reached, the Commission Contract Manager shall forward the electronic version of this report for Energy Commission internal approval. Once the approval is given, the Commission Contract Manager shall provide written approval to the Contractor within 10 working days.
- Submit one bound copy of the Final Report with the final invoice.

Deliverables:

- Draft Final Report
- Final Report

MATCH FUNDS, PERMITS, AND ELECTRONIC FILE FORMAT

Task 1.7 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. While the PIER budget for this task will be zero dollars, the Contractor 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 Contractor can incur any costs for which the Contractor will request reimbursement.

The Contractor shall:

- Prepare a letter documenting the match funding committed to this Agreement and submit it to the Commission Contract Manager at least 2 working days prior to the kick-off meeting:
  1. 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.
  2. 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 Contractor shall identify its owner and provide a contact name, address and telephone number, and the address where the property is located.
    - 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 significantly 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 Contract Manager if during the course of the Agreement additional match funds are received.
- Notify the Commission Contract Manager within 10 working days if during the course of the Agreement existing match funds are reduced. Reduction in match funds may trigger an additional CPR.

Deliverables:

- A letter regarding Match Funds or stating that no Match Funds are provided
- Letter(s) for New Match Funds
- A copy of each Match Fund commitment letter
- Letter that Match Funds were Reduced (if applicable)

Task 1.8 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 Contractor can incur any costs related to the use of the permit(s) for which the Contractor will request reimbursement.

The Contractor shall:

- Prepare a letter documenting the permits required to conduct this Agreement and submit it to the Commission Contract Manager at least 2 working days prior to the kick-off meeting:

1. If there are no permits required at the start of this Agreement, then state such in the letter.
2. 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

- Schedule the Contractor will follow in applying for and obtaining these permits.
- The list of permits and the schedule for obtaining them will be discussed at the kick-off meeting, and a timetable for submitting the updated list, schedule and the copies of the permits will be developed. 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, then provide the appropriate information on each permit and an updated schedule to the Commission Contract Manager.
- As permits are obtained, send a copy of each approved permit to the Commission Contract Manager.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the Commission Contract Manager within 5 working days. Either of these events may trigger an additional CPR.

Deliverables:

- A letter documenting the Permits or stating that no Permits are required
- Updated list of Permits as they change during the Term of the Agreement
- Updated schedule for acquiring Permits as it changes during the Term of the Agreement
- A copy of each approved Permit

Task 1.9 Electronic File Format

The goal of this task is to unify the formats of electronic data and documents provided to the Energy Commission as contract deliverables. Another goal is to establish the computer platforms, operating systems and software that will be required to review and approve all software deliverables.

The Contractor shall:

- Deliver documents to the Commission Contract Manager in the following formats:
- Data sets shall be in Microsoft (MS) Access or MS Excel file format.
- PC-based text documents shall be in MS Word file format.
- Documents intended for public distribution shall be in PDF file format, with the native file format provided as well.
- Project management documents shall be in MS Project file format.
- Request exemptions to the electronic file format in writing at least 90 days before the deliverable is submitted.

Deliverables:

- A letter requesting exemption from the Electronic File Format (if applicable)

PAC

Task 1.10 Establish the PAC

The goal of this task is to create an advisory committee for this Agreement.

The PAC should be composed of diverse professionals. The number can vary depending on potential interest and time availability. The Contractor's Project Manager and the Commission Contract Manager shall act as co-chairs of the PAC. The exact composition of the PAC may change as the need warrants. PAC members serve at the discretion of the Commission Contract Manager. It is expected that the Steering Committee, composed of selected affiliate representatives, will comprise the PAC for this project.

Other qualified professionals spanning the following types of disciplines may be asked to serve on the PAC:

- Researchers knowledgeable about the project subject matter
- Members of the trades who will apply the results of the project (e.g., designers, engineers, architects, contractors, and trade representatives)
- Public Interest Market Transformation Implementers
- Product Developers relevant to project subject matter
- U.S. Department of Energy Research Manager
- Public Interest Environmental Groups
- Utility Representatives
- Members of the relevant technical society committees

The purpose of the PAC is to:

- Provide guidance in research direction. The guidance may include scope of research; research methodologies; timing; coordination with other research. The guidance may be based on:
  - -technical area expertise
  - -knowledge of market applications
  - -linkages between the agreement work and other past, present or future research (both public and private sectors) they are aware of in a particular area.
- Review deliverables. Provide specific suggestions and recommendations for needed adjustments, refinements, or enhancement of the deliverables.
- Evaluate tangible benefits to California of this research and provide recommendations, as needed, to enhance tangible benefits.
- Provide recommendations regarding information dissemination, market pathways or commercialization strategies relevant to the research products.

The Contractor shall:

- Prepare a draft list of potential PAC members that includes name, company, physical and electronic address, and phone number and submit it to the Commission Contract Manager at least 2 working days prior to the kick-off meeting. This list will be discussed at the kick-off meeting and a schedule for recruiting members and holding the first PAC meeting will be developed.
- Recruit PAC members and ensure that each individual understands the member obligations described above, as well as the meeting schedule outlined in Task 1.11.
- Prepare the final list of PAC members.

- Submit letters of acceptance or other comparable documentation of commitment for each PAC member.

Deliverables:

- Draft List of PAC Members
- Final List of PAC Members
- Letters of acceptance, or other comparable documentation of commitment for each PAC Member

Task 1.11 Conduct PAC Meetings

The goal of this task is for the PAC to provide strategic guidance to this project by participating in regular meetings or teleconferences.

The Contractor shall:

- Discuss the PAC meeting schedule at the kick-off meeting. The number of face-to-face meetings and teleconferences and the location of PAC meetings shall be determined in consultation with the Commission Contract Manager. This draft schedule shall be presented to the PAC members during recruiting and finalized at the first PAC meeting.
- Organize and lead PAC meetings in accordance with the schedule. Changes to the schedule must be pre-approved in writing by the Commission Contract Manager.
- Prepare PAC meeting agenda(s) with back-up materials for agenda items.
- Prepare PAC meeting summaries, including recommended resolution of major PAC issues.

Deliverables:

- Draft PAC Meeting Schedule
- Final PAC Meeting Schedule
- PAC Meeting Agenda(s) with Back-up Materials for Agenda Items
- Written PAC meeting summaries, including recommended resolution of major PAC issues

TECHNICAL TASKS

The Contractor shall prepare all deliverables in accordance with the requirements in Task 1.5. Deliverables not requiring a draft version are indicated by marking “(no draft)” after the deliverable name.

Technology Research and Development

Many potentially effective technologies are not making it to the marketplace because of technical gaps. Some of these gaps stem from the fact that fundamental engineering information is not yet available. Others are due to system development and integration needs. WCEC will address these gaps.

The Contractor will prepare a series of Cooling Research and Development reports, which together will comprise the “Cooling Research and Development” section of their 2010, 2011, and 2012 Annual Reports on Cooling. These sections will include, but not limited to, discussion of research, development, and demonstration activities related to the following technologies:

1. Simultaneous Optimization of Heat and Mass Transfer from Surfaces
2. Optimized Hybrid Cooling Systems
3. Zero Peak Cooling Systems
4. Swimming Pools as Heat Sinks for Unitary Air Conditioners
5. Low-Cost Large Chilled Water Storage Systems
6. Next-Generation Rooftop Units (Western Cooling Challenge)
7. Condenser-Air Pre-Cooling

2.0 ~~Annual Task Report Process~~ Technology Research and Development

Background: Each technical task will use the following process for project and deliverable development and approval:

The Contractor shall:

- Perform technical tasks as described in current year activities
- Write the draft Annual Task Report, which will discuss the year's activities relevant to the task, including but not limited to publications, software and hardware documentation, and technology transfer activities during the year prior to the upcoming meeting. It shall also discuss Research and Development (R&D) proposed on this topic for the next year and beyond, and if appropriate, the design, materials and specifications of prototypes to be built. This document shall be submitted to the Commission Contract Manager, to the Steering Committee, and to other relevant individuals for comment at least 10 days prior to the Steering Committee meeting.
- Participate in the annual Steering Committee meeting, to be followed by a Critical Project Review.
- Write a summary of comments on Annual Task Report received during and prior to Steering Committee and CPR meetings.
- Modify the draft Annual Task Report as appropriate, in accordance with comments received, and resubmit for review, comment and approval. The Commission Contract Manager shall provide written approval or request for revision with specific comments within 10 working days of receipt, or draft will be approved by tacit acceptance. The Contractor shall include the final Annual Task Report as a section in an Annual Report on Cooling in the West, which is a consolidated report on activities of WCEC and discussion of policy issues relevant to western cooling, climate and energy. Key elements from this document shall be included in the Final Report for this project.
- Write draft scopes of work and budgets for following year activities, if needed, and submit to Commission Contract Manager for comment and/or approval. Incorporate changes to scopes of work and budgets as needed to obtain final approval.

Deliverables:

- First Annual Report on Cooling in the West
- Second Annual Report on Cooling in the West
- Third Annual Report on Cooling in the West
- Annual Task Reports as listed in each subtask
- Steering committee comments as listed in each subtask

- Scopes of work and budgets for following year(s) as listed in each subtask

2.1 Simultaneous Optimization of Heat and Mass Transfer from Surfaces

Background: The market acceptance of current evaporative cooling equipment is influenced by three key factors:

1) cooling capacity and efficiency (particularly per unit volume),

2) the impact of scaling on performance (both capacity and efficiency), and

3) water consumption.

The optimization of these three factors starts with the core of these systems, which is the evaporation/heat-exchange surface. Existing products are generally based on convenient materials and/or standard geometries, indications being that performance can be improved considerably, particularly with respect to the impacts of scaling on both performance and required water use.

This subtask will investigate and attempt to improve the performance of wetted evaporative surfaces and heat exchangers at both the macroscopic and microscopic levels. Activities will include: investigation of wicking surface materials and alternative micro-scale geometries, understanding the impacts of materials and geometry on scale build-up, and the impact of scale on heat transfer and evaporative performance. In addition, we expect to uncover materials and geometries that will improve energy performance, while also minimizing water use.

Objective: to understand and improve the performance of wetted evaporative surfaces and heat exchangers at both the macroscopic and microscopic levels.

First year activities

The Contractor shall:

- Conduct a literature search for previous published work on this topic.
- Build an apparatus to test both surface performance and geometry performance
- Investigate alternative-material properties, including wicking performance, conductivity, affinity to scaling minerals
- Conduct experiments that quantify the performance of different materials.
- Prepare first Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- First Annual Task Report on Simultaneous Optimization of Heat and Mass Transfer from Surfaces
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated Second year activities

- Conduct experiments to analyze the impacts of scaling on surface performance

- Design and build alternative geometries to maximize heat transfer performance and evaporative effectiveness
- Conduct experiments that quantify the performance of 1-3 geometries that are intended to maximize heat transfer performance and evaporative effectiveness.
- Perform additional tasks as approved
- Prepare second Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Second Annual Task Report on Simultaneous Optimization of Heat and Mass Transfer from Surfaces
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated Third year activities

- Develop and test a complete prototype, looking at efficiency, capacity, scaling impacts, and water consumption.
- Perform additional tasks as approved
- Prepare third Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Third Annual Task Report on Simultaneous Optimization of Heat and Mass Transfer from Surfaces
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Task 2.2 Optimized Hybrid Cooling Systems

Background: Rooftop units (RTUs) cool the majority of non-residential buildings in California. Typical rooftop units (RTUs) cool a mixture of outdoor ventilation air and building return air using direct expansion vapor compression technology. In dry climates, new high efficiency indirect evaporative heat exchangers can deliver pre-cooled outdoor air at “below-indoor” temperatures, allowing use of 100% outdoor air for all applications. New, simpler and more efficient “hybrid” RTU designs are now possible that combine vapor-compression components with the new indirect evaporative heat exchangers. The WCEC has analyzed several configurations, and has developed and documented a concept labeled the “Optimized Hybrid Cooling System” (OHCS). With the vapor-compression evaporator in the building exhaust air stream, this technology promises 10-15% energy savings compared to the next best hybrid configuration, and significantly extends the climate range of hybrid RTU applicability. The concept builds on prior work by Dr. John Dartnall in Melbourne, Australia. The major advantages over conventional RTUs are that OHCS’s:

1) Use a downsized compressor and refrigerant coils, reducing cost and weight

2) Satisfy non-peak loads without compressors, saving substantial cooling electricity consumption

3) Reduce peak demand by more than 40%

4) Supply 100% fresh air, with greatly reduced blower energy consumption, and

5) Improve the efficiency of “economizer” fresh-air cooling.

Objective: to evaluate the viability of an optimized hybrid cooling system concept that combines an advanced evaporative heat exchanger with vapor-compression cooling components and promises the highest possible efficiency in a hybrid rooftop unit.

First year activities

The Contractor shall:

- Conduct a literature search for previous published work on this topic.
- Conduct laboratory tests that evaluate the performance limits associated with different exhaust air conditions
- Based on test results, quantitatively compare OHCS to other hybrid RTU options
- Prepare first Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- First Annual Task Report on optimized hybrid cooling system
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated second year activities

The Contractor shall:

- Work with selected manufacturing partner to build and test full prototype
- Based on test results and cost projections, revise design and review economics
- Perform additional tasks as approved
- Prepare second Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Second Annual Task Report on optimized hybrid cooling system
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated third year activities

- Assess progress and recommend system improvements in the WCEC Annual Cooling Report
- Work with utilities and manufacturing partner to get field testing funded and conducted
- Perform additional tasks as approved

- Prepare third Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Third Annual Task Report on optimized hybrid cooling system
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Task 2.3 Zero Peak Cooling Systems

Background: Cooling is an unwelcome load for electric utilities because it requires significant generation capacity while providing only modest revenues. The increasing popularity of grid-connected Photovoltaic's (PV) and the "zero energy buildings" concept suggests the potential for a "Zero Peak Cooling" (ZPC) program to eliminate cooling demand from the grid and increase implementation rates for both PV and advanced cooling systems. With "generator-level" credits, ZPC systems could offer improved cost-effectiveness compared to either the PV or cooling systems alone. However, due to the imperfect alignment of PV output and cooling loads, some form of energy storage (either thermal or electrical) is needed to eliminate cooling impacts on the grid.

Implementing ZPC will broaden the market for PV systems through utility incentives that purchase the most valuable possible on-site generation. Broad implementation of ZPC systems will reduce peak demand growth and dependence on non-renewable energy, eliminate ratepayer cooling costs, enhance utility distribution reliability, and improve air quality by reducing fossil-fuel combustion.

Objective: to identify and implement a viable California-based Zero Peak Cooling Initiative that completely removes cooling demands from the electricity grid and effectively uses excess PV output on non-peak days.

First year activities

The Contractor shall:

- Conduct a literature search for previous published work on this topic.
- Define base-case buildings
- Evaluate energy storage options
- Develop a ZPC model and simulate system combinations in selected climates
- Estimate costs for preferred cases and evaluate overall economics
- Prepare first Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- First Annual Task Report on zero peak cooling system
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated Second year activities

The Contractor shall:

- Develop a detailed implementation plan and schedule
- Develop prototype Title 20 compliance process and forms
- Assist utilities with a controlled prototype implementation program
- Perform additional tasks as approved
- Prepare second Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Second Annual Task Report on zero peak cooling system
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated third year activities

The Contractor shall:

- Revise Title 20 compliance process and forms based on prototype experience
- Develop ongoing results evaluation methodology and process
- Assist utilities to implement statewide program
- Perform additional tasks as approved
- Prepare third Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Third Annual Task Report on zero peak cooling system
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Task 2.4 Swimming Pools as Heat Sinks for Unitary Air Conditioners

Background: The heating requirements of residential and recreation-center swimming pools, combined with the space cooling requirements of homes and recreation facilities, represent an unnecessary waste of energy and peak electrical power. In brief, the concept of simultaneously rejecting heat from condensers to the atmosphere, while burning natural gas to heat swimming pools does not make sense.

In addition to the energy waste associated with rejecting air-conditioner heat to the atmosphere rather than providing it to a swimming pool in need of heating, the efficiency of the air conditioner can generally be increased by rejecting the heat to the pool, particularly during peak cooling periods. The reason for this efficiency increase is that the efficiency of an air conditioner increases as the refrigerant temperature required to reject the heat decreases.

During peak cooling periods the outdoor air temperature is generally over 100 degrees, as compared to a pool temperature of approximately 80 degrees. Moreover, the refrigerant generally needs to be 35 degrees warmer than the outdoor air temperature for an air cooled condenser, whereas it needs to be only 20 degrees warmer than the water temperature for a water-to-refrigerant heat exchanger. Thus, under peak conditions, the refrigerant can be 35 degrees cooler when rejecting the heat to the pool, and is still 15 degrees cooler when the outside air temperature is equal to the pool temperature.

These cooler temperatures nominally translate to 15 to 70% efficiency improvements, depending on the outdoor air conditions and the type of refrigerant being used. Older R-22 systems increase their efficiency by roughly 1% per degree temperature reduction, whereas the percentage improvement is closer to 2% for newer R-410A systems.

This project attempts to address the problem by augmenting and validating previously developed tools for simulating the combined performance of unitary air conditioning systems and swimming pools. The purpose of these tools is to simulate pool water temperatures, air conditioner compressor energy use, pumping power, and water evaporation over the course of a season for different climates. It addition this project will also provide a demonstration of field performance.

Objective: to develop and evaluate tools to analyze the use of swimming pools as a heat rejection medium for residential and light commercial air conditioning systems, and to test the performance of the both the technology and the performance tools in the field.

First year activities

The Contractor shall:

- Conduct a literature search for previous published work on this topic.
- Refine existing WCEC energy flow analysis tool to include analysis of control strategies as well the thermal response of swimming pools to the rejected heat
- Complete a field test in a home to validate the concept and exercise the model
- Prepare first Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- First Annual Task Report on swimming pools as heat sinks for unitary air conditioners
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated Second year activities

The Contractor shall:

- Expand the analysis tool to apply to larger non-residential pools, e.g. university recreation centers (as de-superheater or sub-cooler
- Solicit and select at least 2 non-residential demonstration projects with associated utility support.
- Perform additional tasks as approved

- Prepare second Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Second Annual Task Report on swimming pools as heat sinks for unitary air conditioners
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated third year activities

The Contractor shall:

- Conduct third year tasks according to final agreed plan in 2nd ARC
- Prepare third Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Third Annual Task Report on swimming pools as heat sinks for unitary air conditioners
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Task 2.5 Low-Cost Large Chilled Water Storage Systems

Background: Cooling causes both daily and annual peak electricity demand throughout California and the Southwestern U.S. This means that thermal storage, including chilled water storage, can strongly influence the magnitude of these peaks. In addition, a significant fraction of the cooling in these climates could be satisfied using “natural” evaporative and night-radiative cooling processes that can be coupled with Chilled Water Storage (CWS). During extremely hot weather, vapor-compression cooling can also be applied off-peak to chill the storage water if and when natural processes cannot fully satisfy cooling loads. However, for such a system to work, large water volumes are required, and current CWS costs discourage implementation of this peak-reduction methodology. Lower-cost CWS systems, combined with “generator-level” peak-demand-reduction credits, could provide customers with cost-effective elimination of 80% of their peak cooling demand for many non-residential buildings.

Thus, low-cost CWS systems can thus serve as on-demand, on-site electricity generation. Broad implementation of low-cost CWS systems could reduce peak demand growth and dependence on non-renewable energy, reduce ratepayer cooling costs, enhance utility distribution reliability, and improve air quality by reducing fossil-fuel combustion.

Objective: to develop and implement viable, low-cost chilled-water storage systems that combine with evaporative, radiative, and vapor-compression cooling processes to remove 80% of peak cooling demands from the electricity grid.

First year activities

The Contractor shall:

- Conduct a literature search for previous published work on this topic.

- Design proposed low-cost CWS options and for 2-3 base-case buildings
- Develop CWS cost/performance model and simulate options in selected climates
- Prepare first Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- First Annual Task Report on Low-Cost Large Chilled Water Storage Systems
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated Second year activities

The Contractor shall:

- Solicit and select demonstration projects and associated utility support
- Develop and implement monitoring plan for projects
- Provide technical assistance in design and construct of demonstration projects
- Perform additional tasks as approved
- Prepare Second Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Second Annual Task Report on Low-Cost Large Chilled Water Storage Systems
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated third year activities

The Contractor shall:

- Prepare and conduct Low-Cost Chilled-Water Storage workshops
- Perform additional tasks as approved
- Prepare third Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Third Annual Task Report on Low-Cost Chilled-Water Storage Systems
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Task 2.6 Next-Generation Rooftop Units (Western Cooling Challenge)

Background: Rooftop packaged units (RTU) are the standard heating, ventilation and air conditioning (HVAC) system for light commercial and large retail buildings. At the request of the WCEC steering committee and large retailers, the Western Cooling Challenge (WCC) was developed and announced at the Retailer's Energy Alliance (REA) in June 2008. Previous CEC PIER funding was used to support the initiation of the WCC. The next phase of our WCC efforts is focused principally on developing the information needed to allow WCC participants to make use of the energy savings and peak demand reduction benefits of WCC compliant units.

Much of these efforts involve the development and use of tools that can be used to analyze the performance of these units in different climates, and under different operating conditions. Utility energy efficiency program administrators, regulators and government agencies need information on which to base incentive payments for WCC units. Building owners need to know the benefits and costs of buying and installing WCC units. In addition, laboratory and field testing of WCC units needs to be managed and overseen by WCEC.

Our plan is that once a unit has successfully completed laboratory testing, it will be field tested under the auspices of utility Emerging Technology programs prior to being. This step is needed prior to getting WCC technologies into mainstream utility incentive programs. WCEC will facilitate the work needed to complete pilot market introduction. According to our published schedule, WCC units will be available on the market by January 1, 2011, at which time we will plan and conduct a market introduction event including manufacturers, building owners and utility representatives.

Objective: Completion of the WCC initiative by implementing the steps needed to have market ready units by January 1, 2011 that are then launched on the path to achieving a significant market share.

First year activities

The Contractor shall:

- Manage laboratory testing of WCC entries
- Conduct a Stakeholder WCC Technology Briefing
- Initiate field testing of WCC units
- Conduct cost effectiveness analyses based on simulations of annual energy use in different California climate zones
- Prepare first Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- First Annual Task Report on Western Cooling Challenge
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated Second year activities

The Contractor shall:

- Conduct additional field testing and emerging technology pilot programs for WCC units
- Recruit end-use customers and utilities using the results of laboratory, field and simulation efforts
- Conduct market introduction events
- Verify and refine energy-use simulation tools
- Perform additional tasks as approved
- Prepare Second Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Second Annual Task Report on Western Cooling Challenge
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated third year activities

The Contractor shall:

- Continue support of the WCC with the REA, CA Department of General Services and electric utilities
- Initiate follow-on challenge that addresses performance features that could not be captured by the WCC
- Perform additional tasks as approved
- Prepare third Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Third Annual Task Report on Western Cooling Challenge
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Task 2.7 Condenser-Air Pre-Cooling

Background: The efficiency of vapor-compression air conditioning systems is strongly correlated with the temperature to which they reject heat (i.e. the temperature at the condenser). For a standard air-cooled systems in non-residential buildings, the efficiency typically drops linearly with increasing ambient air temperature at roughly 1% per ^{o}F for equipment using R-22 refrigerant, and roughly 2% per ^{o}F for equipment using R-410A refrigerant. As R-22 is being phased out, and new equipment generally uses R-410A, this drop in efficiency is becoming more acute, particularly with respect to performance under peak cooling demand conditions.

This project investigates techniques that reduce condenser-air inlet temperatures by evaporating water in the airstream entering the condenser, thereby reducing the temperature experienced by the condenser, and thus increasing the efficiency of the air conditioning system. Two promising techniques will be evaluated in this project. The first is passive wicking of condensate generated at the evaporator coil for rooftop cooling units, and the second is the use of pressurized misting nozzles that eliminate the need for evaporative media upstream of the condenser coil.

Objective: to develop and test systems that use evaporation of either condensate or externally supplied water to reduce condenser air inlet temperatures.

First year activities

The Contractor shall:

- Investigate optimal wicking materials and select preferred material
- Assess typical condensate production from California RTUs
- Fabricate and test two wicking devices that evaporate condensate
- Conduct an in-situ test of a wicking device
- Prepare first Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- First Annual Task Report on Condenser Air Pre-Cooling
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated Second year activities

The Contractor shall:

- Finalize proprietary documentation for wicking device
- Provide technical assistance to selected wicking device business partner
- Investigate particle size and hardness mineral treatment for misting nozzles
- Assess economics of misting nozzle system alternatives
- Perform additional tasks as approved
- Prepare Second Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Second Annual Task Report on Condenser Air Pre-Cooling
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated third year activities

The Contractor shall:

- Fabricate and test preferred misting nozzle system
- Conduct in-situ test of misting nozzle system
- Prepare and conduct condenser pre-cooling workshop
- Perform additional tasks as approved
- Prepare third Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Third Annual Task Report on Condenser Air Pre-Cooling
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Task 2.8 Improving Energy Efficiency in the Hospitality Sector

Background: The hospitality industry as a whole consumes about 4% of California's electricity and about 6.4% of its natural gas. Heating, cooling, and ventilation are major contributors to the energy cost for this industry, and are of special concern because they impact the overall experience of hospitality customers. A major issue is thermal distribution. Many hotels have package heating and cooling units, but larger hotels sometimes have central plant hydronic systems with baseboard heat or fan coils. There is a promising technology for reducing energy costs in these hydronic systems, but it needs further testing and demonstration in operating facilities.

Objective: to investigate and quantify the energy savings associated with using a microencapsulated phase change material (PCM) to improve the efficiency and capacity of hydronic systems used for heating and cooling. Although there are a number of other applications for this technology, this project will investigate its application to the hospitality industry, in particular to hotels.

First Year Activities:

The Contractor shall:

- **Apply the hydronic-system retrofit to at least one building. This will include recruiting appropriate sites, conducting the engineering required to successfully apply the technologies (including satisfying any owner/operator concerns), and ensuring that the work is properly carried out.**
- **Preparation of a First Annual Task Report on PCM in Hydronic Systems that includes but is not limited to a discussion of site selection, engineering required for specific sites selected, preliminary results, and any other pertinent issues.**
- **Record comments from the Steering Committee meeting.**
- **Prepare Following year Task Scopes-of-Work and Budgets, if needed.**

Deliverables:

- **First Annual Task Report on PCM in Hydronic Systems**
- **Comments from Steering Committee meeting**
- **Following year Task Scope of Work and Budgets, if needed**

Anticipated Second Year Activities:

The Contractor shall:

- **Measure the performance of the technology and the energy savings that it provides (both gas and electricity). This activity will include non-energy measurements to assess the performance of the technology.**
- **Determine project cost effectiveness (capital cost versus energy cost savings) for the application.**
- **Prepare Second Annual Task Report on PCM in Hydronic Systems that includes but is not limited to** a **discussion and analysis of the performance and cost-effectiveness of the technology.**
- **Record comments from the Steering Committee meeting.**
- **Prepare Following year Task Scopes-of-Work and Budgets, if needed.**

Deliverables:

- **Second Annual Task Report on PCM in Hydronic Systems**
- **Comments from Steering Committee meeting**
- **Following year Task Scopes-of-Work and Budgets, if needed**

Anticipated Third Year Activities:

The Contractor shall:

- **Create a Development Analytical Tool for analyzing the expected performance and cost effectiveness in other hospitality buildings, as well as estimating of the overall energy saving potential for California and barriers to overcome in order to realize the potential.**
- **Publicize the results of the entire project by posting full reports on the WCEC website for download and publication through appropriate WCEC educational outreach channels.**
- **Develop publicity documents for the WCEC website such as case study/fact sheets and reports that highlight the findings of this project to other hospitality facilities and organizations and other venues, including ASHRAE and local utility energy centers.**
- **Prepare a Third Annual Task Report on PCM in Hydronic Systems that includes but is not limited to a discussion of the development analytical tool, estimates of energy-savings potential of PCMs in California, and barriers to realization of potential.**
- **Record comments from the Steering Committee meeting.**
- **Prepare following year task scopes of work and budgets, if needed.**

Deliverables:

- **Development Analytical Tool**
- **Third Annual Task Report on PCM in Hydronic Systems**
- **Publicity documents for WCEC website, including fact sheets and reports.**
- **Comments from Steering Committee meeting**
- **Following year Task Scopes-of-Work and Budgets, if needed**

Task 2.9 Building Envelope Sealing Using Adhesive Mist

Background: Leaky building envelopes are a major obstacle to reducing energy use related to cooling and heating. For existing buildings in particular, sealing envelopes manually is challenging, labor-intensive and costly, and is often avoided. A simple and inexpensive method for sealing envelopes is needed that can be systematically applied to new construction and renovation projects by construction laborers.

An existing process uses pressurized air and polymer particles to seal leaks in duct work. This process puts escaping air under pressure and causes polymer particles to stick first to the edges of a leak, then to each other until the leak is closed. The technology was developed within the Indoor Environment Program at Lawrence Berkeley National Laboratory, primarily by Mark Modera. The research was funded by the U.S. Environmental Protection Agency, U.S. Department of Energy, the Electric Power Research Institute and the California Institute of Energy and Environment. The University of California was granted initial patents in 1996 and 1999, and Aeroseal holds an exclusive license to the technology for use in ducts.

A conceptually similar approach has shown promise in pilot-scale for sealing whole building envelopes at the time of construction or major renovation. The process, initially tested with support from the U.S. DOE Building America program, used Aeroseal equipment and supplies. However, for optimal effectiveness the new process requires a different adhesive formulation and application equipment. Ultimately there will be no business connection or intellectual property overlap between the machines, processes and adhesives developed, and the Aeroseal technology.

The technology will likely provide better tightness levels and automated documentation of tightness at a considerably lower cost than current manual envelope sealing methods. The benefits should include quicker, less-expensive compliance with codes, reduced infiltration loads (heating and cooling), and peak electricity demand savings.

Objective: to further evaluate and develop the use of aerosol-based leakage sealing for building envelopes. The most appropriate applications for the technology include: single-family and multi-family new construction, single-family homes at the time of occupancy change or major renovation, light commercial new construction, light commercial buildings at the time of tenant improvement, and stairwells in a wide variety of commercial buildings.

First Year Activities

The Contractor shall:

- **Analyze the implications of aerosol envelope sealing from the point of view of building energy efficiency codes in new and existing residential and commercial buildings. This will include examining sealant material performance requirements (i.e., flame and smoke, longevity, hardness, IAQ, and VOCs).**
- **Conduct lab tests of the application of appropriate sealant materials. This effort will entail using the UC laboratory facility (test "box" with 8-ft ceiling) to test the sealing performance of alternative materials that meet the various codes and standards. Alternative materials include those that dry harder than existing products. A large building-sealant manufacturer will provide appropriate sealant materials for testing.**
- **Develop alternative hardware for sealing. This effort will involve use of stand-alone aerosol injectors in combination with a standard blower door to produce the sealing.**
- **Prepare a First Annual Task Report on Building Envelope Sealing using Adhesive Mists that includes but is not limited to an analysis of the performance of adhesive mist envelope sealing techniques, a description of alternative hardware, and a summary of the results of lab and field testing.**
- **Record comments from the Steering Committee meeting.**
- **Prepare Following year Task Scopes-of-Work and Budgets, if needed.**

Deliverables:

- **First Annual Task Report on Building Envelope Sealing using Adhesive Mists**
- **Comments from Steering Committee meeting**
- **Following year Task Scope of Work and Budgets, if needed**

Anticipated Second Year Activities:

The Contractor shall:

- **Field test and develop an application protocol for different building applications. This effort will explore the practical implications of applying the technology in different situations. These efforts will be used to develop protocols that will then be tested by commercial firms.**
- **Identify code compliance issues (e.g., fire and electrical) or other barriers to achieving maximum penetration.**
- **Prepare a Second Annual Task Report on Building Envelope Sealing using Adhesive Mists that includes but is not limited to a discussion of application protocol, results of tests, and code compliance issues.**
- **Record comments from the steering committee meeting.**
- **Prepare following year scopes of work and budgets, if needed.**

Deliverables:

- **Second Annual Task Report on Building Envelope Sealing using Adhesive Mists**
- **Comments from Steering Committee meeting**
- **Following year Task Scope of Work and Budgets, if needed**

Anticipated Third Year Activities:

The Contractor shall:

- **Estimate overall energy and peak demand savings potentials for the state of California. Use existing studies and models of residential and commercial buildings to evaluate the savings associated with tighter envelopes.**
- **Estimate the cost-effectiveness of the technology, and compare the cost (e.g., cost per square foot) versus the energy cost savings (e.g., savings per square foot).**
- **Prepare a Third Annual Task Report on Building Envelope Sealing using Adhesive Mists that includes but is not limited to estimates of energy impacts for California, and cost effectiveness of technology.**
- **Record comments from the steering committee meeting.**

Deliverables:

- **Third Annual Task Report on Building Envelope Sealing using Adhesive Mists**
- **Comments from Steering Committee meeting**

Task 2.10 Gray Water Reuse for Evaporative Cooling

Background: Using evaporative processes for cooling buildings provides substantial efficiency improvements over 'dry' cooling, but water use is a major concern for water agencies across California and is likely to become more so in the future. A fraction of the water consumed by small system evaporative cooling is used to dilute concentration of dissolved solids, which is disgarded from the system and wasted. Treatment systems are available that may be able to reduce the volume of this waste but they have not been adapted and demonstrated in these small systems. There may also be techniques for re-using so-called 'gray water' from lavatories for evaporative cooling. If these prove practical then this water, which at present is discarded, can substantially mitigate the need for additional water for evaporative cooling.

Although the focus of the project is on small-scale systems (i.e. residential and light commercial), the results are expected to be applicable to larger evaporative cooling systems, as one of the goals is to understand when and why particular treatment/management options work or do not work with respect to temperature and water conditions.

Objective: to examine technologies and techniques to reduce the need for maintenance water, and examine the use of grey water to eliminate any on-site water use associated with evaporative cooling.

First Year Activities:

The Contractor Shall:

- **Conduct laboratory testing of the implication of water treatment and management on the performance of different evaporative cooling systems, including the pumps**

used for recirculation in many of these systems. This testing will focus on small-scale experiments to understand the mechanisms impacting performance and to validate theoretical results.

- **Work with manufacturers on understanding and solving practical maintenance and water use problems.**
- **Publicize results through posting interm reports on the WCEC website. Present interim results at ASHRAE, local utility energy centers, and other venues if warranted.**
- **Prepare a First Annual Task Report on Gray Water Reuse for Evaporative Cooling that includes but is not limited to a discussion of water treatment and management, work with manufacturers, and publicity materials developed.**
- **Record comments from the Steering Committee meeting.**
- **Prepare following year scope of work and budgets, in needed.**

Deliverables:

- **First Annual Task Report on Gray Water Reuse for Evaporative Cooling**
- **Comments from Steering Committee meeting**
- **Following year Scope of Work and Budgets, if needed**

Anticipated Year Two Activities:

The Contractor shall:

- **Conduct laboratory testing of the implication of water treatment and management on the performance of different evaporative cooling systems, including the pumps used for recirculation in many of these systems. This testing will focus on small-scale experiments to understand the mechanisms impacting performance and to validate theoretical results.**
- **Conduct theoretical and analytical investigations to develop a mechanistic understanding of how scaling occurs in different equipment and components. This will include determining when and why particular treatment/management options work or do not work.**
- **Conduct a laboratory test of the impact of using grey water in an actual evaporative cooler.**
- **Publicize results through posting interim reports on the WCEC website. Present results at ASHRAE, local utility energy centers, and other venues if warranted.**
- **Prepare a Second Annual Task Report on Gray Water Reuse for Evaporative Cooling that includes but is not limited to laboratory testing and analysis of gray water implications for evaporative cooling, results of cooling trial, and publicity reports.**
- **Record comments from the Steering Committee meeting.**
- **Prepare following year scope of work and budgets, if needed.**

Deliverables:

- **Second Annual Task Report on Gray Water Reuse for Evaporative Cooling**
- **Comments from Steering Committee meeting**
- **Following year Scope of Work and Budgets, if needed**

Anticipated Year 3 Activities

- **Analysis of the cost-effectiveness of developing a grey water system for evaporative cooling versus a standard system (non-grey water).**
- **Estimate the overall energy and water savings potential for California.**
- **Publicize results by posting full reports on WCEC website. Present results at ASHRAE, local utility energy centers, and other venues.**
- **Prepare a Third Annual Task Report on Gray Water Reuse for Evaporative Cooling that includes but is not limited to cost-effectiveness analysis, energy and water-savings potential, and publicity materials.**
- **Record comments from the Steering Committee meeting.**
- **Prepare following year scope of work and budgets, if needed.**

Deliverables:

- **Third Annual Task Report on Gray Water Reuse for Evaporative Cooling**
- **Comments from Steering Committee meeting**
- **Following year Task Scopes-of-Work and Budgets, if needed**

Task 2.11 New Techniques for Ground Source Heat Pumps

Background: Ground-source heat pumps (GSHP) are known to be energy efficient for cooling and heating because the ground maintains a relatively constant temperature year-round and has a large heat capacity. The major barrier to the wider use of ground-source heat pumps is the cost of drilling and installing the field of geothermal wells or trenches. Horizontal or directional drilling techniques may be a more cost-effective way to develop these wells, but need more development, validation, and publicization. New types of tubing also show promise but need validation. The key attraction of this project is that the reported cost reductions of GSHP installations, if proven, could make Net Zero Energy homes possible at a reasonable first-cost.

There are several new technologies that manufacturers claim will dramatically reduce the first cost of GSHP installations. One of these technologies is being brought to market by a Northern California start-up company, ActGeothermal. It uses 20-foot long 2-inch diameter bores in a radial (spherical) geometry, in lieu of 200-foot vertical wells with much larger diameters to connect to the ground. Both the ActGeo and another technology (Kelix) use concentric piping (instead of a U-tube) to improve heat transfer, and thereby reduce the required depth for the bore holes. These companies, along with ClimateMaster (a maker of heat pump equipment), and SMUD are partners on this

project. The Sacramento Municipal Utility District (SMUD) is providing cost share in the amount of $100,000. Demonstration and Research projects would be carried out in both SMUD and PG&E districts, and potentially in SCE and SDG&E districts as well if suitable sites can be located.

Thermal mass of the water in swimming pools can be utilized in much the same way as the earth in a GSHP system. This has proven to be a potentially useful for cooling systems. Water-source heat pumps are typically used in both GSHP and swimming pools as thermal mass applications. Synergy therefore exists between GSHP and swimming pools as thermal mass that should help to bring down the costs of both as familiarity grows with these systems. Use of swimming pools as thermal mass will continue to be developed under this project.

Objectives: to evaluate and, if successful, publicize the cost-effectiveness and performance of new alternative drilling systems for GSHPs that could significantly reduce the installed first cost of these heat pumps.
Explore the cost-effectiveness and practicality of further reducing first cost by using swimming pools to handle a fraction of the heat rejection/absorption required by a single-family home.

First Year Activities:

The Contractor Shall:

- **Conduct a thermal analysis of the various alternative piping/ground-interface systems.**
- **Investigate the practicality of including swimming pools for a portion of the heat rejection/capture for these installations.**
- **Field test the performance of the different alternatives (including heating and cooling season performance).**
- **Prepare a First Annual Task Report on New Techniques for Ground Source Heat Pumps that includes but is not limited to thermal analysis of piping and ground interface systems, use of swimming pools as heat reservoirs, and field test results**
- **Record comments from the Steering Committee meeting.**
- **Prepare following year scope of work and budgets, if needed.**

Deliverables:

- **First Annual Task Report on New Techniques for Ground Source Heat Pumps**
- **Comments from Steering Committee meeting**
- **Following year Task Scope of Work and Budgets, if needed**

Anticipated Second Year Activities:

The Contractor shall:

- **Investigate the practicality of including swimming pools for a portion of the heat rejection/capture for these installations.**

- **Field test the performance of the different alternatives (including heating and cooling season performance).**
- **Perform a detailed cost-effectiveness analysis of the various alternatives.**
- **Estimate the overall energy and peak demand savings potentials for the state of California.**
- **Prepare a Second Annual Task Report on New Techniques for Ground Source Heat Pumps that includes but is not limited to results of swimming pool analysis, performance, potential, and cost effectiveness of various alternatives.**
- **Record comments from the Steering Committee meeting.**
- **Prepare following year scope of work and budgets, if needed.**

Deliverables:

- **Second Annual Task Report on New Techniques for Ground Source Heat Pumps**
- **Comments from Steering Committee meeting**
- **Following year Task Scope of Work and Budgets, if needed**

Anticipated Third Year Activities:

The Contractor shall:

- **Perform a detailed cost-effectiveness analysis of the various alternatives.**
- **Estimate the overall energy and peak demand savings potentials for the state of California.**
- **Prepare reports for publishing and download from the WCEC website.**
- **Present findings at ASHRAE functions, local utility energy centers, and other venues.**
- **Prepare a Third Annual Task Report on New Techniques for Ground Source Heat Pumps that includes but is not limited to cost-effectiveness analysis, energy savings potential, publicity material, and a discussion of outreach activities.**
- **Record comments from the Steering Committee meeting.**

Deliverables:

- **Third Annual Task Report on New Techniques for Ground Source Heat Pumps**
- **Comments from Steering Committee meeting**
- **Following year Task Scopes-of-Work and Budgets, if needed**

Task 3 Industry Application of Advanced Cooling Technologies

Technologies that have passed the field demonstration stage often need additional support to move them effectively into the market, including development of modeling tools, treatment within codes and standards, and acceptance within the engineering and design communities. Another of the important roles of the WCEC is to get information about advanced cooling technologies into the market, and to educate developers, implementers, or end-users about the technologies.

The WCEC will assist our partners by providing support for industry application of cooling technologies proven effective in western climates. This will include providing support to industry stakeholders through participation in industry associations and development of tools, participation in activities that lead to enhancement of state and federal codes and standards, and carrying out communication and outreach activities.

Task 3.1. Industry Support

First year activities

The Contractor shall:

- Identify strategic industry associations, and participate in 1 or more industry associations, including ASHRAE. Representatives of WCEC will attend the twice yearly ASHRAE meetings and participate actively in several committees, such as Standard 152 (Method of test for residential thermal energy distribution), Guideline 1.2 (commissioning of existing buildings), TC 5.7 (evaporative cooling), TC 6.5 (radiant cooling), and TC 6.9 (thermal energy storage).
- Work with industry to identify missing tools that would be helpful in advancing the application of advance cooling systems, and coordinate the development of the necessary tools. As the cornerstone deliverable of this activity, each contract year WCEC shall advance development of analytical models of one or more advanced cooling technology.
- Prepare first Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- First Annual Task Report on Industry Support
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated second year activities

The Contractor shall:

- Conduct second year tasks according to final agreed plan in 1st ARC
- Prepare second Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Second Annual Task Report on Industry Support
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated third year activities

The Contractor shall:

- Conduct third year tasks according to final agreed plan in 2nd ARC

- Prepare third Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Third Annual Task Report on Industry Support
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Task 3.2. Codes and Standards

First year activities

The Contractor shall:

- Work with utilities and with CEC staff to conduct a Title 24 Scoping Study for the WCEC Portfolio of cooling technologies. This shall include both changes to the existing requirements and development of new requirements. The WCEC shall carry out the testing, demonstrations, or analyses necessary to evaluate the suitability of one or more technology for proper inclusion in the next round of Title 24 or Title 20. The technologies that might be addressed include different radiant or evaporative cooling technologies.
- Participate in the process of developing regionally-specific DOE air-conditioning standards, by attending conference call meetings of the DOE advisory committee to advocate for efficient hot-dry air conditioners. The WCEC shall review and comment on proposed test procedures and other specifications and policy analyses as they arise.
- Prepare first Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- First Annual Task Report on Codes and Standards
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated second year activities

The Contractor shall:

- Conduct third year tasks according to final agreed plan in 1st ARC
- Prepare second Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Second Annual Task Report on Codes and Standards
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated third year activities

The Contractor shall:

- Conduct third year tasks according to final agreed plan in 2nd ARC
- Prepare third Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Third Annual Task Report on codes and Standards
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Task 3.3 Education and Outreach

First year activities

The Contractor shall:

- Analyze educational needs on advanced cooling technologies of various groups, including university students, practitioners, and community college/ trade school students.
- Prepare and deliver a short University Extension course to disseminate information about WCEC research, development, and demonstrations, and other PIER technologies. The target audience for these courses is existing practitioners seeking to update their knowledge of available technologies and advance their skills in delivering these technologies.
- Deliver one focused workshop to solicit feedback and transfer knowledge gained based upon advanced cooling research, development, and demonstrations. The target audience for these workshops shall be industry participants and different California stakeholders.
- Build upon the existing WCEC website by providing additional information about cooling technologies. The website will host information developed by on advanced cooling systems including but not limited to utility-funded research activities that can be made available to benefit other utilities and the public. In each contract year, a plan for website changes shall be developed, the changes will be implemented, and existing information will be maintained and updated.
- Attend emerging technology forums, public agency and policy hearings, and other venues that will be used to disseminate information to policy makers, industry, and the public
- Prepare first Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- First Annual Task Report on Education and Outreach
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated second year activities

The Contractor shall:

- Conduct second year tasks according to final agreed plan in 1st ARC
- Prepare second Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Second Annual Task Report on Education and Outreach
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed

Anticipated third year activities

The Contractor shall:

- Conduct third year tasks according to final agreed plan in 2nd ARC
- Prepare third Annual Task Report, participate in Steering Committee meeting and prepare following year Task Scopes of Work and Budgets as needed, according to process described in section 2.0

Deliverables:

- Third Annual Task Report on Education and Outreach
- Comments from Steering Committee meeting
- Following year Task Scopes-of-Work and Budgets, if needed