

STATE OF CALIFORNIA

STATE ENERGY RESOURCES  
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION - RE: University of California Los Angeles

**RESOLVED**, that the State Energy Resources Conservation and Development Commission (Energy Commission) approves Contract 500-11-013 to implement auto demand response with the campus WINSmartGrid communication platform. Research will determine the most effective methods of deploying demand response based on the behavior of the campus residential consumers. (PIER electricity funding.) Contact: Mike Gravely. (5 minutes)

**FURTHER BE IT RESOLVED**, that this document authorizes the Executive Director to execute the same on behalf of the Energy Commission.

**CERTIFICATION**

The undersigned Secretariat to the Commission does hereby certify that the foregoing is a full, true, and correct copy of a Resolution duly and regularly adopted at a meeting of the California Energy Commission held on March 14, 2012.

AYE: [List of Commissioners]

NAY: [List of Commissioners]

ABSENT: [List of Commissioners]

ABSTAIN: [List of Commissioners]

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Harriet Kallemeyn,  
Secretariat

**CONTRACT REQUESTS FORM (CRF)**

CEC-94 (Revised 5/11)

CALIFORNIA ENERGY COMMISSION


 New Contract 500-11-013     Amendment to Existing Contract: \_\_\_\_\_ Amendment Number: \_\_\_\_\_

Division	Contract Manager:	MS-	Phone	CM Training Date
Energy Research and Development	Jamie Patterson	43	916-327-2342	1/21/1998

Contractor's Legal Name	Federal ID Number
The Regents of the University of California on behalf of the Los Angeles Campus	95-6006143

Title of Project
Implementation of Demand Response in a University Campus

Term	Start Date	End Date	Amount
New/Original Contract	4/2/2012	4/30/2014	\$ 499,999

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

Amendment #	End Date (mm/dd/yy)	Amount

### Business Meeting Information

Proposed Business Meeting Date	3/14/2012	<input type="checkbox"/> Consent	<input checked="" type="checkbox"/> Discussion
Business Meeting Presenter	Mike Gravely	Time Needed:	5 minutes

### Agenda Item Subject and Description

Possible approval of Contract 500-11-013 for \$499,999 with the Regents of the University of California on behalf of the Los Angeles Campus to implement Auto Demand Response (AutoDR) with the campus WINSmartGrid communication platform. Research conducted under this contract will determine the most effective methods of deploying demand response based on the behavior of the campus residential consumers. (PIER electricity funding.) Contact: Mike Gravely. (5 minutes)

**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 contract is to perform research on the genesis of a new architecture design for AutoDR by interfacing UCLA's WINSmartGrid communications platform with OpenADR, create a new AutoDR model based on this architecture, perform simulations on the AutoDR model, and based on the results of the simulations create a research test-bed within a UCLA residential campus dwelling so as to perform a field study involving consumers, with the objective of addressing the challenges faced by utilities and providing conclusions and recommendations about the proposed hypotheses for AutoDR programs. Technology transfer activities will include the possible application to campuses across the UC and CSU Systems and will explore new applications of AutoDR which include EV's and Smart Appliances.

### California Environmental Quality Act (CEQA) Compliance

- 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":  
 Contract will not cause direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment because the project involves research, modeling, and design activities.
- 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: \_\_\_\_\_
    - Common Sense Exemption. 14 CCR 15061 (b) (3)
 Explain reason why contract is exempt under the above section: \_\_\_\_\_
  - 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.

**CONTRACT REQUESTS FORM (CRF)**

CEC-94 (Revised 5/11)

CALIFORNIA ENERGY COMMISSION



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	\$499,999	Yes	PIER-E	10-11	501.0271	\$499,999
ECAA	\$		\$					\$
State- ERPA	\$		\$					\$
Federal	\$		\$					\$
PIER - E	\$499,999		\$					\$
PIER - NG	\$		\$					\$
Reimbursement	\$		\$					\$
Other	\$		\$					\$
<b>TOTAL:</b>	<b>\$499,999</b>	<b>TOTAL:</b>	<b>\$499,999</b>		<b>TOTAL:</b>			<b>\$499,999</b>
Reimbursement Contract #:					Federal Agreement			

Contractor's Administrator/ Officer		Contractor's Project Manager	
Name:	Kim Duiker	Name:	Prof. Rajit Gadh
Address:	P.O. Box 951406 11000 Kinross Ave., Ste 211	Address:	46-147D Engineering Iv Building Campus 159710
City, State, Zip:	Los Angeles, CA 90095-2000	City, State, Zip:	Los Angeles, CA 90095-0001
Phone/ Fax:	(310) 794-0165 / (310) 943-1658	Phone/ Fax:	(310) 267-4892 / (310) 206-4830
E-Mail:	Kduiker@research.ucla.edu	E-Mail:	gadh@seas.ucla.edu

Contractor Is
<input type="checkbox"/> Private Company (including non-profits) <input checked="" type="checkbox"/> CA State Agency (including UC and CSU) <input type="checkbox"/> Government Entity (i.e. city, county, federal government, air/water/school district, joint power authorities, university from another state)

Selection Process Used
<input type="checkbox"/> Solicitation _____ Solicitation #: _____ # of Bids: _____ Low Bid? <input type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> Non Competitive Bid (Attach CEC 96) <input checked="" type="checkbox"/> Exempt Interagency

Civil Service Considerations
<input checked="" type="checkbox"/> Not Applicable (Contract is with a CA State Entity or a membership/co-sponsorship) <input type="checkbox"/> Public Resources Code 25620, et seq., authorizes the Commission to contract for the subject work. (PIER) <input type="checkbox"/> The Services Contracted: <input type="checkbox"/> are not available within civil service <input type="checkbox"/> cannot be performed satisfactorily by civil service employees <input type="checkbox"/> are of such a highly specialized or technical nature that the expert knowledge, expertise, and ability are not available through the civil service system. <input type="checkbox"/> The Services are of such an: <input type="checkbox"/> urgent <input type="checkbox"/> temporary, or <input type="checkbox"/> occasional nature that the delay to implement under civil service would frustrate their very purpose.
<b>Justification:</b> Public Resources Code 25620, et seq., authorizes the Commission to contract for the subject work. (PIER)

# CONTRACT REQUESTS FORM (CRF)



Payment Method			
<input checked="" type="checkbox"/> A. Reimbursement in arrears based on:			
<input type="checkbox"/> Itemized Monthly	<input checked="" type="checkbox"/> Itemized Quarterly	<input type="checkbox"/> Flat Rate	<input type="checkbox"/> One-time
<input type="checkbox"/> B. Advanced Payment			
<input type="checkbox"/> C. Other, explain:			

Retention			
1. Is contract subject to retention?		<input checked="" type="checkbox"/> No	<input type="checkbox"/> Yes
If Yes, Do you plan to release retention prior to contract termination?		<input type="checkbox"/> No	<input type="checkbox"/> Yes

Justification of Rates	
The overhead rates charged in this contract are the standard negotiated rates between the Energy Commission and the University of California. All other rates are standard published rates for the UC.	

Disabled Veteran Business Enterprise Program (DVBE)	
1. <input checked="" type="checkbox"/> Not Applicable	
2. <input type="checkbox"/> Meets DVBE Requirements	DVBE Amount:\$ _____ DVBE %: _____
<input type="checkbox"/> Contractor is Certified DVBE	
<input type="checkbox"/> Contractor is Subcontracting with a DVBE: _____	
3. <input type="checkbox"/> Requesting DVBE Exemption (attach CEC 95)	

Is Contractor a certified Small Business (SB), Micro Business (MB) or DVBE?		<input checked="" type="checkbox"/> No	<input type="checkbox"/> Yes
If yes, check appropriate box:		<input type="checkbox"/> SB	<input type="checkbox"/> MB <input type="checkbox"/> DVBE

Is Contractor subcontracting any services?		<input checked="" type="checkbox"/> No	<input type="checkbox"/> Yes
If yes, give company name and identify if they are a Small Business (SB), Micro Business (MB) and/or DVBE:			

Miscellaneous Contract Information			
1. Will there be Work Authorizations?		<input checked="" type="checkbox"/> No	<input type="checkbox"/> Yes
2. Is the Contractor providing confidential information?		<input checked="" type="checkbox"/> No	<input type="checkbox"/> Yes
3. Is the contractor going to purchase equipment?		<input checked="" type="checkbox"/> No	<input type="checkbox"/> Yes
4. Check frequency of progress reports			
<input type="checkbox"/> Monthly <input checked="" type="checkbox"/> Quarterly <input type="checkbox"/> _____			
5. Will a final report be required?		<input type="checkbox"/> No	<input checked="" type="checkbox"/> Yes
6. Is the contract, with amendments, longer than a year? If yes, why?		<input type="checkbox"/> No	<input checked="" type="checkbox"/> 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.			

# CONTRACT REQUESTS FORM (CRF)



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

<b>Task #</b>	<b>CPR</b>	<b>Task Name</b>
1	N/A	Administration
2	X	Design of Architecture, Modeling and Simulation
3	X	Design and Build Test-bed and Perform Field Study
4		Technology Transfer Activities

**KEY NAME LIST**

<b>Task #</b>	<b>Key Personnel</b>	<b>Key Subcontractor(s)</b>	<b>Key Partner(s)</b>
1	Professor Rajit Gadh		
2	Professor Rajit Gadh		
3	Professor Rajit Gadh		
4	Professor Rajit Gadh		

**GLOSSARY**

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

<b>Acronym</b>	<b>Definition</b>
ADR / AutoDR	Automated Demand Response
CDMA	Code Division Multiple Access
CPR	Critical Project Review
CPUC	California Public Utilities Commission
DR	Demand Response
Energy Commission	California Energy Commission
EV	Electric Vehicle
HVAC	Heating Ventilation and Air Conditioning
LBNL	Lawrence Berkeley National Laboratory
OpenADR	Open Automated Demand Response (system developed by LBNL)
PAC	Project Advisory Committee
PIER	Public Interest Energy Research
SEP	Smart Energy Profile
UCC.1	Uniform Commercial Code (Financing Statement)
UCLA	University of California – Los Angeles
WINSmartGrid	Wireless Internet Smart Grid (research platform developed by UCLA)

## **Problem Statement**

Automated demand response (AutoDR) has the potential to allow utilities to reduce peak load by monitoring and controlling various loads within their customers' premises. However, there are significant uncertainties regarding the implementation of ADR, including whether AutoDR programs offered by utilities will be accepted by their customers (the consumers); whether communications infrastructure is adequately robust and reliable to transmit the demand response (DR) signals from their source to the desired loads such as heating ventilation and air conditioning (HVAC) systems, electrical appliances/other plug loads, lighting systems, and more recently, electric vehicles; and whether utilities can be assured of automatic and intelligent reduction of a given amount of electrical load within a given time interval in their territories.

This agreement will involve the following activities: (1) performing research on the genesis of a new architecture design for AutoDR by interfacing the University of California – Los Angeles (UCLA) WINSmartGrid communications platform with Open Automated Demand Response (OpenADR); (2) creating a new AutoDR model based on this architecture; (3) performing simulations on the AutoDR model; and (4) based on the results of the simulations, creating a research test-bed within a UCLA residential campus dwelling so as to perform a field study involving consumers with the objective of addressing the uncertainties above; and (5) providing conclusions and recommendations about the proposed hypotheses for AutoDR programs.

## **Problem Statement Narrative: Research of AutoDR in Campus Residential Dwelling**

Rapid load escalations resulting in demand peaks typically require the additional generation from peaker plants or the reduction of load through large-scale load shedding or demand response signals sent to customers. These demand peaks can occur throughout the spring, summer, and fall, with the highest peaks generally occurring in mid September. DR enables balancing of the demand (via DR) with the supply on the grid by modifying demand in real-time at varying levels of granularity. While existing DR programs emphasize larger enterprise customers, the addition of residential customers (when aggregated across an entire city or region) could potentially form a significant source of demand reduction. At the level of a microgrid such as a university, there is a substantial population that lives on campus. This residential segment when aggregated could potentially form a significant source of AutoDR.

The purpose of this project is to perform research, modeling, and design activities to create a DR test-bed, and to study the effectiveness of AutoDR within a residential load on campus. While DR signals are traditionally sent primarily to loads, this agreement will coordinate with the UC Davis Plug-In Hybrid and Electric Vehicle Research Center to investigate sending DR signals to Electric Vehicle (EV) batteries in addition to the loads with the intent of switching off EV batteries or using them as a source of electricity that is sent back to the grid. This agreement will investigate having an integrated framework for DR that combines batteries within EVs into the residential loads.

At a technical level, this agreement aims to: investigate different levels and modalities of automation in load curtailment, control models, secure messaging schemes, leverage multiple communication technologies (particularly wireless communications), and maintain interoperability between the Smart Grid automation and information architecture layers. Research, test-bed creation, and technology demonstration will utilize UCLA's WINSmartGrid platform as a smart in-building monitoring, communications, and control layer for the campus grid test-bed.

The communications sense-and-control infrastructure that is part of WINSmartGrid will carry the data payload that would allow smart monitoring as well as control of loads including HVAC, smart appliances/plug loads, lighting, and batteries within EVs. The WINSmartGrid system will be interfaced with the OpenADR system to create an integrated AutoDR architecture within UCLA that tests demand response signals originating at the source from the OpenADR server, passing through various smart control software programs residing on the Internet cloud or on embedded devices, and eventually reaching individual controllable energy loads.

While the AutoDR research proposed is estimated to have potential delays of the order of minutes, it is expected that for faster ramp-up requirements (potentially within seconds), aggregated batteries belonging to EVs may offer a better alternative over classic loads such as HVAC. Such requirements may form the basis of ancillary services in the electricity sector in the future. UCLA functions as its own sub-utility powered by its natural gas-powered cogeneration plant within the territory of its local utility, the Los Angeles Department of Water and Power. The project would allow an integrated demonstration of OpenADR with WINSmartGrid within UCLA that would be a microcosm of the city of Los Angeles.

### **Goals of the Agreement**

The goals of this Agreement are to:

- Investigate, demonstrate, and quantify the potential for peak load reduction via an AutoDR research demonstration project at UCLA.
- Research, create, and demonstrate AutoDR within the UCLA campus residential dwelling load.
- Research, test, and evaluate the information and network interface between the OpenADR platform from Lawrence Berkeley National Laboratory (LBNL) and WINSmartGrid platform from UCLA for demonstrating AutoDR.
- Research and test: (1) the ability of the campus residential infrastructure using WINSmartGrid to support and carry AutoDR signals generated using OpenADR and; (2) the ability and effectiveness of these signals to reach the target loads and provide the desired peak load reduction via AutoDR.
- Research and evaluate customer response and behavior to AutoDR programs.
- Investigate and research scale-up of the campus demonstration DR architecture into that of the Los Angeles Department of Water and Power's infrastructure model and potentially with San Diego Gas & Electric, Southern California Edison, Pacific Gas & Electric, and other UC campuses.

- Propose hypotheses for the success of AutoDR in campus residential dwelling loads and prove, disprove, or partially prove these hypotheses.

### **Objectives of the Agreement**

The objectives of this Agreement are to:

1. Propose and create a model for interfacing the WINSmartGrid from UCLA with OpenADR from LBNL that combines sensing, communication, intelligence and control layers.
2. Create simulations interfacing WINSmartGrid and OpenADR with the purpose of studying the performance of signal origination from OpenADR and signal termination at the loads.
3. Create an AutoDR test-bed within the UCLA living lab using OpenADR so as to study AutoDR research issues including DR signal reliability, communications system performance, sense-and-control performance, load response in residential microgrid, DR effectiveness in load reduction, DR characterization by load type, and consumer response to DR.
4. Study the performance and behavior of heterogeneous communications infrastructure (consisting of serially connected multiple networks including Wi-Fi, 3G, Zigbee, Z-wave, Homeplug, and SEP 1.0/1.x/2.0) to carry the signal and convert it at connected gateway points, so as to eventually reach its destination, enable the AutoDR control system by way of such a communications network, and to study and evaluate scaling up of this network.
5. Generate data from the AutoDR test-bed and analyze such data for studying the response to DR signals by the university students using mobile devices. The purpose is to evaluate the relationship between different DR programs offered and the load reduced, the speed of reduction of load as a function of the level of automation of DR, the technical delays in the signaling, the technical delays in the load reduction, and the relationship between various parameters and load reduction.
6. Study the participation and interaction by UCLA students in the DR program during DR events throughout the year.
7. Based on research results above draw conclusions about existing data, communications, monitoring, control and information models in the AutoDR space.
8. Make test-bed implementation, research, and conclusions available to the public via research publication journals and conferences, reports, and workshops.
9. Propose, refine, and define a methodology to prove, disprove, or partially prove key hypotheses pertaining to the success of customer participation, platform characteristics to support AutoDR, and the ability of the DR technology to function in an integrated fashion using OpenADR and WINSmartGrid to achieve the desired magnitude of DR.

## **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.
- 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

- 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

### **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 5 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 5 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 exact composition of the PAC may change as the need warrants. PAC members serve at the discretion of the Commission Contract Manager.

The PAC may be composed of qualified professionals spanning the following types of disciplines:

- The UC Davis Plug-In Hybrid & Electric Vehicle Research Center
- 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 from San Diego Gas & Electric, Southern California Edison, Pacific Gas & Electric and others as appropriate.
- 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**

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.

**Task 2 Design of Architecture, Modeling and Simulation**

The goals of this task are to design an AutoDR architecture that interfaces OpenADR with WINSmartGrid, and to subsequently develop a model for the AutoDR system for a UCLA residential hall with the goal of creating a simulation environment to be used as a research platform for simulating AutoDR.

**The Contractor shall:**

- Design an architecture that combines sensing, communication, intelligence, and control layers within WINSmartGrid from UCLA with the system architecture of OpenADR from LBNL.
- Use the architecture to develop a model for AutoDR in the context of residential halls with smart loads integrating aggregated batteries from EVs for initial load ramp-up, to enable a localized smart grid while utilizing, where relevant, standards-based plug-and-play components for sensing, communications and control.
- Document the architecture design and AutoDR model in an “Architecture Design and AutoDR Model” Document.
- Design AutoDR experiments based on the existing architectures of OpenADR and WINSmartGrid, and with input from students living in residential halls and from facilities management personnel.
- Create simulations for AutoDR based on the designed experiments that would simulate a DR signal originating from a server and terminating at the residential hall loads and EV batteries.

- Develop and refine hypotheses pertaining to the success of the following simulations: customer participation; platform characteristics to support AutoDR; and the ability of the DR technology to function in an integrated fashion using OpenADR and WINSmartGrid to achieve the desired magnitude of DR within the desired time.
- Document the experiment design, simulation results, and refined hypothesis in an “Experiment Design, Simulation Results and Refined Hypothesis” Document.
- Hold a workshop to share the results of the first year’s research. Invite the PAC, utilities, vendors, representatives, and universities to the workshop to obtain feedback on the research approach.
- Document the workshop results in a Workshop White Paper.

**Deliverables:**

- Developed Architecture Design and AutoDR Model Document
- Experiment Design, Simulation Results and Refined Hypothesis Document
- Workshop White Paper (Task 2)

**Task 3 Design and Build Test-bed and Perform Field Study**

The goals of this task are to design and build a test-bed to enable AutoDR, carry out field study research on the test-bed, and form conclusions on the proposed hypotheses.

**The Contractor shall:**

- Based on results of the simulation in Task 2, design a research test-bed on the campus in a residential hall consisting of residence units with one or more students each. This test-bed would combine WINSmartGrid and OpenADR.
- Design a field study based on results of the above research test-bed, which would consist of various test scenarios. Each scenario would: (1) define different types of DR programs and their relevant signals to be transmitted through the test-bed originating from OpenADR and reach the desired loads; and (2) define the measure of effectiveness of DR signals for load reduction.
- Obtain feedback on the field study from the project advisory members and incorporate relevant changes to the field study.
- Document the test-bed and field study design in a “Test-bed and Field Study Design” Document.
- Participate in a CPR as per Task 1.2 after designing the test-bed and prior to building the test-bed.
- Build an AutoDR test-bed that would enable study of performance and behavior of heterogeneous communications infrastructure consisting of serially connected multiple networks (such as Wi-Fi, CDMA, Zigbee, Z-wave, Homeplug, and SEP 1.0/1.x/2.0) to carry the DR signal from OpenADR and convert it at connected gateway points within WINSmartGrid. This would eventually allow the DR signal origination from OpenADR to reach its destination load, and (in the case of EVs) to develop a client to receive such DR signal and convert it to a data format acceptable to the EV charger or the EV directly, to enable the AutoDR control system by way of such a communications network, and to study scaling up of this network.

- Generate data by conducting experiments using the AutoDR test-bed and research. Evaluate and analyze such data for studying: (1) the response to DR signals by the university students; (2) the relationship between different DR programs offered in the experiment and the load reduced; (3) the rate of load reduction as a function of the level of automation of DR; (4) the technical delays in the signaling, the technical delays in the load reduction; and (5) the relationship between various parameters and load reduction.
- Draw research conclusions on the following topics: DR signal reliability, communications system performance, sense-and-control performance, load response in a residential microgrid, DR effectiveness in load reduction, DR characterization by load type, DR ramp-up performance in the presence of aggregated batteries from EVs in residential halls, and consumer response to DR.
- Work to further refine and to prove, disprove, or partially prove key hypotheses pertaining to the success of the customer's participation, platform characteristics to support AutoDR, and the ability of the DR technology to function in an integrated fashion using OpenADR and WINSmartGrid to achieve the desired magnitude of DR.
- Document the AutoDR test-bed description, field study results, conclusions, and finalized hypotheses in an "AutoDR Test-bed description, Field Study Results, Conclusions, and Final Hypotheses" Document.
- Host a workshop at which the PAC, utilities, vendors, government representatives, and universities would be invited with the objective of disseminating the results of the research, simulations, and field study.
- Document the results of the workshop in a Workshop White Paper.

**Deliverables:**

- Test-bed and Field Study Design Document
- CPR Report
- AutoDR Test-bed description, Field Study Results, Conclusions, and Final Hypotheses Document
- Workshop White Paper (Task 3)

**Task 4 Technology Transfer Activities**

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

**The Contractor shall:**

- Prepare a Technology Transfer Plan. The plan shall explain how the knowledge gained in this project will be made available to the public, the other UC campuses, Campuses of the California State University system, and large customers of San Diego Gas & Electric, Southern California Edison, and Pacific Gas & Electric. The level of detail expected is least for research-related projects and highest for demonstration projects. Key elements from this report shall be included in the Final Report for this project.
- Conduct technology transfer activities in accordance with the Technology Transfer Plan. These activities shall be reported in the Quarterly Progress Reports.

- Develop, where relevant, research publications for journals and conferences so as to disseminate results to a broader audience.

**Deliverables:**

- Technology Transfer Plan
- Any research publications in journals or conferences that are generated as part of this project and a final power-point presentation on the project.

**EXHIBIT A, ATTACHMENT A-2**  
**CONTENT AND FORMAT OF PROGRESS REPORTS – RECOMMENDED**

**PROGRESS REPORT for**  
**Project Title, Agreement Number**  
**Month, Year**

Contractor Project Manager:  
 Commission Project Manager:

**What we planned to accomplish this period**

[This is taken directly from the section on “What we expect to accomplish during the next period” from the last progress report.]

**What we actually accomplished this period**

[Concise description of major activities and accomplishments.]

**How we are doing compared to our plan**

[Explain the differences, if any, between the planned and the actual accomplishments. Describe what needs to be done, if anything, to get back on track.]

**Significant problems or changes**

[Describe any significant technical or fiscal problems. Request approval for significant changes in scope of work, revised milestone due dates, changes in key personnel assigned to the project, or reallocation of budget cost categories. If none, include the following statement: “Progress and expenditures will result in project being completed on time and within budget.”]

**What we expect to accomplish during the next period**

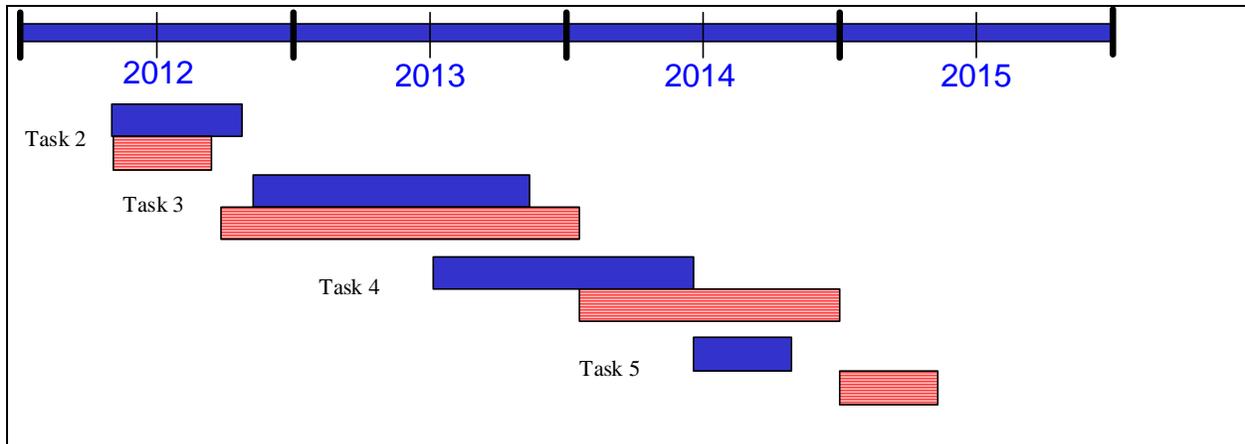
[Concise description of major activities and accomplishments expected. This will be transferred to the next progress report]

**Status of Milestones and Deliverables:**

[This should be the complete list as contained in the revised scope of work. Highlight differences between actual and planned.]

Description	Start Date		Due Date		Status (%)
	Planned	Actual	Planned	Actual	
Identify top 3 assessment candidates	4/15/12	4/15/12	5/1/12	5/1/12	Ontime 100%
Develop test plan	4/20/12	<b>4/10/12</b>	7/7/12	<b>6/10/12</b>	<b>Ahead</b> <b>100%</b>
Analyze experimental data	5/1/12	<b>6/1/12</b>	1/1/13	<b>2/1/13</b>	<b>Delayed</b> <b>25%</b>

## EXHIBIT A, ATTACHMENT A-2 CONTENT AND FORMAT OF PROGRESS REPORTS – RECOMMENDED



### Overall schedule for the \_\_\_\_\_ project.

[Planned is solid blue, actual is red striped. This work flow diagram needs to correlate with the schedule in Exhibit A. This example has been prepared as a Word Picture, but a comparable Excel diagram or Gantt chart is fine.]

### Overview of Fiscal Status: (See invoices for detail.)

[It is useful to track the rate of expenditure of project funds. The most useful way to do this is to compare the actual expenditure rate with the planned expenditure rate. You get the planned rate at the beginning of the project, so it becomes a baseline. If you change course at a critical project review, you should show the original and the modified baseline, and then track against the new one.]

### Photographs:

Include photographs where appropriate to document progress. The photos shall be shot with color print film or be very high quality digital photos (at least 300 dpi).

### Evidence of Progress:

If there is a long time between interim deliverables, then attach evidence of the progress being made (e.g., test data, product mock-ups, field site descriptions, preliminary analyses) to the progress reports to allow the Commission Contract Manager to review contract progress and gauge the quality of research results.

### Notes:

The tracking for tasks and money is generally done at the major task level, but this depends on the project and fiscal controls.

Notice that there is no technical detail in these reports. This should come in specific deliverables so that critical project management information does not get lost. If the contractor is reporting monthly, but submitting invoices quarterly, then use the three monthly reports as an equivalent quarterly report. Do not make them write another report just to get paid.

The progress report on each project should be 1-2 pages long (plus photographs) and take about 1 hour to prepare for each reporting period.

## EXHIBIT A ATTACHMENT A-3 RESUMES

### **Rajit Gadh**

Professor, Dept. of Mechanical and Aerospace Engineering, Henry Samueli School of Engineering and Applied Science

Director, Smart Grid Energy Research Center, Henry Samueli School of Engineering and Applied Science  
Fellow of the American Society of Mechanical Engineers

### **Education**

BS 1984 Indian Institute of Technology (IIT), Kanpur, India

Department of Mechanical Engineering

MS 1986 Cornell University, Ithaca, NY

Department of Mechanical Engineering

Ph.D. 1991 Carnegie Mellon University (CMU), Pittsburgh, PA

### **Relevant Publications**

Siddhartha Mal, and, Rajit Gadh, Real-Time Push Middleware and Mobile Application for Electric Vehicle Smart

Charging and Aggregation, Accepted for publication June 15, 2011, Special Issue on: Context-Aware System and

Intelligent Middleware for Smart Grid International Journal of Communication Networks and Distributed Systems

(IJCND) 2011.

Rajit Gadh, WINSmartgrid - Wireless Internet Smart Grid, Presented at the "Computational Needs for the Next

Generation Electric Grid workshop, Abstract published in workshop, Organized by Department of Energy, April

18-20, 2011.

Rajit Gadh, Convergence for the Smart Grid - On the technology opportunities for Future Cyber-Physical Energy

Systems, invited short paper at New Research Directions for Future Cyber-Physical Energy Systems conference,

June 3-4, 2009, Baltimore, Maryland

Harish Ramamurthy, B. S. Prabhu and Rajit Gadh, Asad Madni, Wireless Industrial Monitoring and Control using

a Smart Sensor Platform, IEEE Sensors Journal, 7(5), May 2007, 611-618.

Xiaoyong Su, B.S. Prabhu, Chi-cheng Chu and Rajit Gadh, Scalable Vector Graphics (SVG) Based Multi-Level

Graphics Representation for Engineering Rich-Content Exchange in Mobile Collaboration Computing Environments, Journal of Computing and Information Science in Engineering -- June 2006 -- Volume 6,

Issue 2,

pp. 96-102

### **Other publications**

Katina Michael, George Roussos, George Huang, Arunabh Chattopadhyay, Shiv Prabhu, Chi-cheng Chu, and, Rajit

Gadh, "Planetary-Scale RFID Services in an Age of Ubervveillance, IEEE Proceedings, Transactions of the IEEE,

Proceedings of the IEEE (2010), Volume: 98, Issue: 9, Pages: 1663-1671

Byung Youn Song, Arunabh Chattopadhyay, Peter Chu, B. S. Prabhu, Jae Yeol Lee, Rajit Gadh and Junghoon Lee,

Feasibility Study of Surface Acoustic Wave RFID for Information Processing Asset Management, IEEE RFID, Las

Vegas, April 16, 2008

Xiaoyong Su, Chi-Cheng Chu, B.S. Prabhu, and Rajit Gadh, On the Identification Device Management and Data

Capture via WinRFID Edge-Server, IEEE Systems Journal, 1(2), Dec 2007, 95-104.

## EXHIBIT A ATTACHMENT A-3 RESUMES

Harish Ramamurthy, B. S. Prabhu, Rajit Gadh and Asad Madni, "Smart sensor platform for industrial monitoring

and control", 4th IEEE SENSORS 2005, Irvine, California.

Xiaoyong Su, B. S. Prabhu, Chi-Cheng Chu, and Rajit Gadh, "Middleware for Multimedia Mobile Collaborative

System," SECOND BEST PAPER PRIZE in excellence for applied research, Presented at IEEE ComSoc sponsored,

Page 2 of 2

THIRD ANNUAL WIRELESS TELECOMMUNICATIONS SYMPOSIUM (WTS 2004), May 14-15, 2004, CalPoly Pomona, Pomona, California, USA

### **Synergistic Activities**

i) Collaborate with UCLA-WINMEC Center Members including organizations such as Raytheon, Motorola, Hughes Network Systems, and others (<http://winmec.ucla.edu>).

ii) Organized two Thought Leadership Forums at UCLA on Smart Grid developments at a national level – March 18 and June 18. The next is scheduled for November 4. URL <http://winmec.ucla.edu/smartgrid>.

### **Collaborators and other Affiliations**

#### **Past graduate students and their affiliations**

Dr. Xiaoyong Shu – Impinj Corp.

Dr. Tushar Dani – Boeing Corporation

Dr. Shyam Sundar – Siemens

Dr. Hari Srinivasan - United Technologies Research Center

Dr. Zhao Fan – Siebel Systems

#### **Recent collaborators and other affiliations**

Prof. John Uicker – Univ. of Wisconsin-Madison

Dr. B.S. Prabhu – UCLA

Prof. Fritz B. Prinz – Stanford University

Prof. Mario Gerla – UCLA

Dr. Chi-Cheng Chu – UCLA

Dr. Uday Karmarkar – UCLA

Dr. Bruce Dunn - UCLA

Dr. Yang Yang – UCLA

Dr. Jung-in Choi

Dr. Luc Song

Charlie Qi

#### **Graduate and Postdoctoral Advisors**

Prof. Stephen B. Pope – Cornell University, Mechanical Engg;

Prof. Fritz B. Prinz, Stanford University, Mechanical Engg.

#### **Thesis Advisor and Postgraduate-Scholar Sponsor**

Arunabh Chattopadhyay

Siddhartha Mal

Wenbo Shi

Tiana Huang

Rui Huang

Jay Panchal

Ching-yen Chung

Josh Chynoweth