Exhibit A

SCOPE OF WORK

TECHNICAL TASK LIST

Task #	CPR	Task Name
1	N/A	Administration
2	X	Sensor Procurement, Installation and Maintenance
3	X	Intra-hour solar forecasting
4		System Modeling
5		Solar Integration Analysis
6		Distribution Feeder Impact analysis
7	N/A	Technology Transfer Activities

KEY NAME LIST

Task #	Key Personnel	Key Subcontractor(s)	Key Partner(s)
1	Kay Stefferud	UC San Diego	
2	Jan Kleissl	UC San Diego, Advantech	SCE, CAISO, NREL
3	Jan Kleissl	UC San Diego	SCE, CAISO, NREL
4	Jens Schoene		SCE, CAISO, NREL
5	Jens Schoene	UC San Diego	SCE, CAISO, NREL
6	Jens Schoene		SCE, NREL
7	Bob Russ	Advantech--DVBE	SCE, CAISO, NREL

GLOSSARY

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

Acronym	Definition
CAISO	California Independent System Operator
CIMIS	California Irrigation Management Information System
CPR	Critical Project Review
CSI	California Solar Initiative

Acronym	Definition
GOES	Geostationary Operational Environmental Satellite
MW	Megawatt
NREL	National Renewable Energy Laboratory
NSRDB	National Solar Radiation Data Base
NWP	Numerical Weather Prediction
PIER	Public Interest Energy Research
PIRP	Participating Intermittent Resource Program
PV	Photovoltaic
SCADA	Supervisory Control And Data Acquisition
SCE	Southern California Edison
TOV	Temporary Overvoltage
UCC.1	Uniform Commercial Code (Financing Statement)
UCSD	University of California at San Diego
USRE	Utility Scale Renewable Energy
UWIG	Utility Wind Integration Group

Problem Statement

Increasing amounts of solar generation are being planned and sited in California. Solar photovoltaic (PV) and other utility scale renewable energy (USRE) sources present a significant challenge because they are more variable than conventional generation and at the same time subject to environmental factors which are not under the control of utilities. With increasing levels of solar penetration, integrating solar power requires addressing operational and economic factors including choosing the correct locations, types and amount of spinning reserves and/or storage systems to protect the electric grid. Utility grid operation and planning tools lack the ability to model distributed solar power generation and resources. It is likely that the conventional generation mix cannot respond to the rapid ramping of PV output. If hour-ahead solar intermittency or solar generation forecast error becomes comparable to the hour-ahead load forecast error California Independent System Operator (CAISO) will require a significant increase in the supplemental energy stack to meet intra-hour load following needs. In performance-based tariff structures, the economics of solar power on the grid-scale hinges on the ability to predict and balance the impact of transient cloudiness over a large array or a network of sites.

In January 2010, the Department of Energy awarded University of California at San Diego (UCSD) a $1.9M grant for the Advanced Modeling of High Penetration of PV on the Distribution Feeder, and was co-funded by a pending grant from the California Energy Commission-Public Interest Energy Research (PIER) Program. A portion of this grant has a non-redundant solar forecasting task solely related to the UCSD microgrid. Furthermore, the California Solar Initiative (CSI) has announced their intent to fund a $0.6M grant to Kleissl for improvement of solar resources and PV modeling. The CSI grant includes the acquisition and quality control of ground data and a forecasting component solely based on satellite models. Both form the foundation for thisproject . This project is to complement current and pending research by specifically addressing the unfunded work that will develop and demonstrate networks of total sky imagers integrated with satellite solar forecasting across one of the largest solar installation sites in the state of California.

Goals of the Agreement

The goal of this project is to facilitate grid integration of USRE, specifically, 500 megawatts (MW) of PV solar in the Inland Empire region through forecasting, modeling, monitoring, and system impact analysis designed to analyze the effect of solar variability on the reliability, economics and operations.

Objectives of the Agreement

The objectives of this Agreement are to

Reduce intra-hour solar forecasting error by 50%.

Use satellite data combined with sky imagery to track cloud formations and estimate times of cloud cover combined with state-of-the-art meteorological models.

Develop numerical and statistical mathematical models using real-time local and regional meteorological and power output data as well as historical data, to predict wind and solar output seconds, minutes, hours and days ahead of time.

Develop advanced computer models to quantify variations in renewable energy generation at increased levels of penetration. Incorporate the leveling effect of geographic diversity in predictive models.

Develop computer models of the Inland Empire grid with utility scale PV solar generation that are capable of accounting for (1) the effects of the actual solar variability on the reliability, economics, and operations and (2) the effects of the model-predicted solar variability on planning and control decisions. The models will be used in the studies described in the following two items.

Perform a Solar Integration Analysis to assess the detailed impacts of the planned 500 MW’s of PV solar generation in a utility’s territory. A main goal of the analysis is to assess the sensitivity of the solar forecasting time frame and accuracy on the grid with regards to generation resource planning, generation and storage plant siting, transmission planning, and the economics. This effort will result in specific recommendation, which will help the grid accommodate renewable energy’s variable output.

Use the historical and forecasted solar data obtained for the Southern California Edison (SCE) control area in a detailed electrical study that analyses the distribution feeder impact of the additional PV generation. The information on the generation variability will be employed to assess operating practices and system control responses during normal operation and during disturbance on the distribution feeder.

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)

  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

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 any additional costs will be borne by the Contractor.

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 satisfactory progress is not being made, this conclusion will be referred to the Energy 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 Monthly Progress Reports

The goal of this task is to periodically verify that satisfactory and continued progress is made towards achieving the research objectives of this Agreement.

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:

- Monthly 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/

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 5 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/

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 not reimbursable under this Agreement. While the PIER budget for this task will be zero dollars, the Contractor shall show match funds for this task. Permits must be identified in writing and obtained before the Contractor can incur any costs related to the use of the permits 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

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 2.0 SENSOR PROCUREMENT, INSTALLATION AND MAINTENANCE

Task 2.1 Procurement and Installation of Sensor Hardware

The goal of this task is to procure and install sensor hardware at USRE plants in SCE territory.

Contractor Shall

- Procure monitoring equipment consisting of at least two Sky Imagers, five 1-sec irradiance sensors, and 1-sec PV power plant output from 10 PV power plants
- Conduct siting analysis in collaboration with SCE
- Install sensors and establish data sharing agreements with SCE
- Prepare a report describing proposed installation sites and power and connection requirements
- Participate in CPR #1 as per Task 1.2

Deliverables:

- Proposed Installation Sites Report (no draft)
- CPR Report

Task 2.2 Maintain Sensors for the Duration of the Project

The goal of this task is to maintain metering hardware at USRE plants in SCE territory.

Contractor Shall

- Conduct data quality control and site visits
- Prepare a report on data availability, quality and sharing agreements

Deliverables:

- Data Availability and Quality Report (no draft)

Task 2.3 Remove Sensors

The goal of this task is to remove metering hardware if required by SCE.

Contractor Shall

- Remove sensors if required by SCE, and notify the Commission Contract Manager in Progress Report

Deliverables:

- None

TASK 3.0 SOLAR FORECASTING

Task 3.1 Conduct Solar Forecasts

The goal of this task is to set up solar forecasts for USRE plants in SCE territory. Solar forecasts will be performed for SCE's Fontana and surrounding solar rooftop USRE.

Contractor Shall

- Set up the following intra-hour forecasts every second:
  - Clear sky model
  - 24h and 1h persistence forecasts and numerical weather model forecast (as a baseline)
  - Geostationary Operational Environmental Satellite (GOES) forecasts using the Perez model
  - Total sky imager forecasts
- Prepare a report describing procedure for each forecast

Deliverables:

- Forecast Procedures Report (no draft)

Task 3.2 Merge Satellite and Sky Imager Forecast into Optimal Forecast Product

The goal of this task is to evaluate the add-on value of sky imagery for intra-hour solar forecasting.

Contractor Shall

- Develop statistical models to merge sky images from ground and satellite
- Evaluate reduction in intra-hour forecast errors across seasons and sites if sky imagery is used in addition to satellite imagery
- Prepare a report describing intra-hour forecast accuracy for satellite forecast, sky imager forecast, and the combination of the two.

Deliverables:

- Forecast Accuracy Report (no draft)

Task 3.3 Forecast Solar PV Variability And Forecast Uncertainty

The goal of this task is to forecast single and aggregate PV plant variability across the SCE balancing area and to quantify forecast uncertainty to determine ancillary service requirements.

Contractor Shall

- Apply statistical models from task 3.2 to satellite imagery to conduct PV variability forecast

- Refine PV variability forecast using satellite imagery and PV variability measurements.
- Evaluate reduction in aggregate intra-hour forecast errors across the SCE territory.
- Prepare a report describing improvements in intra-hour forecast accuracy for a satellite-only versus a satellite + sky imager ramp rate forecast

Deliverables:

- Improvements in Forecast Accuracy Report (no draft)

Task 3.4 Determine Maximum Solar Variability Rates based on Real Data

The goal of this task is to determine the maximum variability in solar generation. The maximum rate of solar production change will be calculated based on the supervisory control and data acquisition (SCADA) data and estimates from the PV variability across the balancing area calculated in task 3.3.

Contractor Shall

- Use the Fontana cloud analysis and the Fontana SCADA data to calculate the maximum rate of change of solar output (ramp rate) for further analysis in the System Impact Study.
- Prepare a report containing the calculated solar output (ramp rate) based on the data available.
- Participate in CPR #2 as per Task 1.2

Deliverables:

- Calculated Solar Output Report (no draft)
- CPR Report

TASK 4.0 SYSTEM MODELING

Task 4.1 Modeling of Control Area and the Distribution System

The goal of this task is to design models of the Inland Empire grid.

Contractor Shall

- Collect data and build models of the Inland Empire circuit.
- Benchmark the calculated fault current levels and voltage drops with results from previous studies on the same circuits.
- Prepare and document power system models to be used for the solar integration analysis (Task 5.0) and the distribution feeder impact analysis (Task 6.0).

Deliverables:

- Power system models documentation (no draft).

Task 4.2 Modeling of PV Generators

The goal of this task is to develop models of the PV solar generators which are needed to assess the impact of solar variability on the grid.

Contractor Shall

- Collect data and build models for the PV system power variations and response to disturbances.
- Use SCE's real world inverter performance data generated from their inverter testing to verify and, if necessary, refine the PV inverter models.
- Prepare and document PV generation models to be used for the solar integration analysis (Task 5.0) and the distribution feeder impact analysis (Task 6.0).

Deliverables:

- PV generation models documentation (no draft)

TASK 5.0 SOLAR INTEGRATION ANALYSES

The results of this effort will aid SCE in an operational environment by assessing and providing guidance on how SCE can use the data from the solar monitoring and forecasting activities to help the grid to accommodate the variable generation output. The impact of the variable PV output on the grid with regards to generation resource planning, generation and storage plant siting, transmission planning, and the economics will be assessed in this task.

The capacity value of PV generation for long term planning analyses is currently a topic of significant discussion in the PV and electric power industries. Characterizing the PV generation to appropriately reflect the historical statistical nature of the generation output on seasonal, daily, and hourly bases is one of the major challenges. In addition to being variable, solar power production is also a challenge to accurately predict on the time scales of interest to utility planners and operators: day ahead and for long-term planning of system adequacy (i.e., meeting the system peak load during the year). PV energy is more predictable in the hour-ahead time frame, but even then the uncertainty in PV forecasts must be accounted for in utility operation and dispatching. In order to minimize impacts and maximize benefits, each utility that incorporates solar energy must learn how to accommodate the uncertainty and variability of solar energy in their operational and planning practices, and do so while maintaining system reliability.

In the previous tasks of this project, historical data that capture this variability are collected and forecasting models that predict the variability are developed. The objective of this task is to use these data to analyze operating impacts and costs of integrating various levels of PV generation in the SCE control area. To achieve this objective, the statistical information extracted from the historical data and forecasted data will be employed to investigate to what extent PV generation can make a contribution towards system reliability in spite of the fact that it cannot be dispatched directly like most conventional generating resources. The specific tasks associated with this effort are outlined below:

Task 5.1 Assessment of Current Regulation Costs and Control Performance Impacts

The goal of this task is to utilize one of the models developed in Task 4.0 to quantify the effects of the additional PV generation on control performance and regulation costs.

Contractor Shall

- Use the developed model to quantify the effects of the planned 500 MW of PV generation in the SCE control area on the control performance and regulation costs.
- Consult with SCE to define the specific cases for this task.
- Simulate a large number of individual days so that a range of system conditions and PV generation are included in the assessment.
- Assess the impact of the increased regulation burden.
- Prepare a report summarizing the methodology, results, and recommendations of the regulation cost and control performance assessment.

Deliverables:

- Cost and Control Performance Assessment Report

Task 5.2 Evaluation of Increased PV Generation Penetration

The goal of this task is to evaluate the reliability and cost impacts for various PV generation levels.

Contractor Shall

- Evaluate the reliability and cost impacts associated with (1) current PV generation levels, (2) the planned PV generation level of 500 MW, and (3) future PV generation levels above 500 MW. It is likely that at some increased penetration level a limitation in regulating capacity will be encountered.
- Consult with SCE to determine appropriate alternatives or proxies to substitute for regulating capacity.
- Discuss for each PV generation level the impact of the increased regulation burden on the SCE units, as applicable.
- Prepare a report summarizing the methodology, results, and recommendations of the evaluation of the increased PV generation penetration.

Contractor Deliverables:

- Evaluation of Increased PV Generation Penetration Report

Task 5.3 Opportunities for Improved PV Generation Forecasts in Real-Time Operational Planning Functions

The goal of this task is to quantify how short-term PV generation forecasts might be used to reduce system regulation and other operating costs. Results from the PV forecasting model developed in the previous task will form the basis for this investigation.

Contractor Shall

- Use knowledge of what the PV generation model will do over the next minutes to several hours to optimize the regulation strategy. Effects on control performance and regulation cost will be noted.
- Consult with SCE system operators to develop additional strategies for how forecasting information could be utilized if available.
- Provide insight into potential for next-day and longer PV generation forecasting accuracy versus what SCE currently uses. As PV generation increases, next day forecasts may take on additional importance. The contractor will confer with SCE operators and energy traders to identify how improved PV generation forecasts could be used for enhancing system operations.
- Prepare a report summarizing how short-term PV generation forecasts and improved PV generation forecasts might be used to optimize system regulation and reduce costs.

Deliverables:

- Benefits of Improved Forecasts Report (no draft)

TASK 6.0 DISTRIBUTION FEEDER IMPACT ANALYSES

The large-scale integration of PV generation presents a challenge to utilities in that operating practices and system control responses to disturbances on the distribution feeder levels were developed for conventional generation and need to be reaffirmed or, if necessary, revised to account for the inherent variability of PV generation. Solar data are needed to accurately predict the system behavior during normal operation and the response of the distribution feeder to disturbances.

In the previous tasks, historical and forecasted solar data are obtained and a model of the SCE control area is developed to investigate control and planning issues associated with the PV integration on the transmission level. The next logical step is to employ the high-quality solar historical and forecasted data in a detailed electrical study that analyze the distribution feeder impact of the additional PV generation.

Task 6.1 Voltage Control Evaluation

The goal of this task is to simulate voltage regulation and control operations (i.e., number of tap changes and capacitor switching) over the profile of load and PV output variations.

Contractor Shall

- Calculate the voltage fluctuation or flicker.
- Recommend new settings or other design changes to mitigate any problems found.
- Prepare a report summarizing the methodology, results, and recommendations of the Voltage Control Evaluation.

Deliverables:

- Voltage Control Evaluation Report

Task 6.2 Overcurrent Analysis

The goal of this task is to analyze the effect of maximum solar variability on overcurrent protection systems.

Contractor Shall

- Simulate the effect of overcurrent protection system response to three-phase, line-to-line, line-to-line-to-ground, and single-line-to-ground faults at all locations.
- Analyze the effect of solar generation on overcurrent protection systems and recommend new settings or other design changes to mitigate any problems found.
- Prepare a report summarizing the methodology, results, and recommendations of the overcurrent analysis

Deliverables:

- Overcurrent Analysis Report

Task 6.3 Assessment of Islanding Behavior

The goal of this task is to estimate the risk of islanding.

Contractor Shall

- Estimate the risk of islanding, as the probability that PV generation lies in the range from 100% to 110% of the actual load on an isolated feeder segment. This at-risk range is a rule of thumb from previous dynamic simulation studies.
- Recommend switching procedures or other design changes to mitigate any problems found.
- Prepare a report summarizing the methodology, results, and recommendations of the Island Behavior Analysis.

Deliverables:

- Island Behavior Analysis Report

Task 6.4 Temporary Overvoltage (TOV) Analysis

The goal of this task is to simulate TOVs and analyze their effect.

Contractor Shall

- Simulate TOVs and their effect on surge arresters during generation backfeed conditions. Recommend grounding or other design features to mitigate any problems found.
- Prepare a report summarizing the methodology, results, and recommendations of the TOV Analysis.

Contractor Deliverables:

- TOV Analysis Report

Task 6.5 Load-Switching Scenarios

The goal of this task is to model load switching scenarios and determine the maximum PV levels which could be obtained currently.

Contractor Shall

- Consider the voltage control, overcurrent protection, islanding, and grounding issues for load-switching scenarios.
- Establish maximum PV levels that could be installed at the system, beyond which further study would be needed.
- Prepare a report summarizing the methodology, results, and recommendations of the Load-Switching Scenario Study.

Deliverables:

- Load-Switching Scenario Study Report

Task 6.6 Review Existing Relay Protection Settings

The goal of this task is to review existing relay protection settings to assess if the additional generation will cause problems such as sympathetic tripping.

Contractor Shall

- Review existing relay protection settings to assess if the additional generation will cause problems such as sympathetic tripping.
- Recommend new settings or other design changes to mitigate any problems found.
- Prepare a report summarizing the review of existing relay protection settings

Deliverables:

- Existing Relay Protection Settings Report (no draft).

TASK 7 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.

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 level of detail expected is least for research-related projects and highest for demonstration projects. Key elements from this report shall be included in the Final Report for this project.
- Conduct technology transfer activities in accordance with the Technology Transfer Plan. These activities shall be reported in the Monthly Progress Reports.

- Indicate the intended use and users of the project results.

Deliverables:

- Technology Transfer Plan