**Proposed Agreement between California Energy Commission**
**and**

# DOE- Lawrence Livermore National Laboratory

**Title: Using High Speed Computing to Estimate the Amount of Energy Storage and Automated Demand Response Needed to Support California's RPS.**
**Amount: $1,750,000.00**
**Term: 36 months**
**Contact: Steve Ghadiri**
**Committee Meeting: 4/4/2011**

## Funding

| FY | Program | Area | Initiative | Budget | This Project | Remaining Balance | |
|---|---|---|---|---|---|---|---|
| 09 | Electric | ETSI | Smart Grid | $1,796,449 | $750,000 | $0 | 0% |
| 10 | Electric | ETSI | Smart Grid | $6,236,303 | $1,000,000 | $3,016,953 | 48% |

## Recommendation

Approve this agreement with Lawrence Livermore National Laboratory for $1,750,000.00. Staff recommends placing this item on discussion agenda of the Commission Business Meeting.

## Issue

As the California grid increases the penetration of renewables, the intermittency and uncertainty of this renewable generation results in grid stability challenges for the grid operators. Energy storage and the use of fast acting automated demand response (DR) offer solutions to these challenges. Previous PIER funded research estimated that as much as 5000 megawatts of energy storage or alternatives such as automated DR will be needed to respond the grid instabilities. To make a more accurate estimate of the amount of support the grid will need, the LLNL will apply high performance computing technologies to more accurately model the grid operations and more accurately estimate the amount of energy storage and automated DR needed.

## Background

The anticipated increase in deployment of wind and solar generation in the State of California will pose challenges to grid operation. Based on information gained by the California Independent Systems Operator (CAISO), ramping changes of thousands of megawatts can occur in only a few hours. To respond to these ramping and instability issues, energy storage is considered the most effective technology to address this short term and high power energy need. Based on research completed by PIER by automating demand response can provide a energy response that can replicate some of the energy storage needs. Current cost estimates indicate that automated DR can provide these services at a cost of less than 10% of the comparable energy storage costs. Therefore, it is important to know how much energy storage is needed to support the integration of 33 % renewables by 2020 and from that information, determine how much of that need can be met with automated DR.

This study will develop more detailed and complete computer algorithms that can be used to estimate the uncertainty on the grid with 33% renewable generation. Some of this work has already been completed by LLNL for other utility customers. The LLNL team will then develop algorithms to simulate the appropriate responses of conventional generations (like peaker plants), different energy storage technologies (batteries, compressed air, flywheels, etc) and automated DR. The team will than compare the costs and performance of alternative technologies for providing regulation of electric generation under high penetration of intermittent renewables. The researchers propose to estimate regulation requirements by modeling electricity dispatch under uncertainty, and then assessing the resulting mismatches between the total generation and the actual loads. This study will also assess the potential for system instabilities given the penetration of renewables.

## Proposed Work

This study will fully evaluate AutoDR and energy storage to support renewables. As part of this evaluation the costs of alternative technologies for providing regulation of electric generation under high penetration of intermittent renewables will be compared.

This proposed work includes the development of scenarios that probabilistically characterize the system regulation requirement under high penetration of intermittent generation. A simulation test bed will be provided that includes forecasting , unit commitment, and economic dispatch algorithms. Furthermore, performance characteristics of a range of candidate demand response, storage, and generation technologies will be evaluated. All these efforts will result in identifying portfolios of regulation technologies that are effective under a range of possible future configuration of the grid, California Economy, and environment.

Additionally, this study will identify circumstances that tend to lead to system instabilities, characterize them, and quantify the frequency of occurrence. For example, this would examine scenarios that include stressful periods in daily cycles, or yearly conditions such as high/ or low hydro or wind, and forced outages. These studies will generally not analyze a full year in detail, but rather will focus on those time periods when system is stressed. Furthermore, certain improvements to unit commitment, dispatch, and forecasting algorithms will be made which could reduce the incidence and severity of under/over generation. Improved algorithms may suggest that different sets of technologies for regulation will be more effective. Development of these improved algorithms will also yield in assessing the regulation technologies (storage and demand response with a range of response times and energies) requirements and will further assess the benefits of improved system. Finally, a set of future scenarios will be developed that may present future challenges to the regulation of the system for further investigation. These might include changes in hydro availability, El Nino years, penetration of EVs, penetration of distributed generation, large scale storage, changes in load shape, greater frequency of heat storms, changes in wind generation cycles, etc. These scenarios will be selected based on their likelihood of occurrence and on their potential challenges to grid regulation that they might present.

Regulation could be provided using dispatchable generation, storage, and demand response, which may be available at a range of response times and energies. LLNL proposes to estimate regulation requirements by modeling electricity dispatch under uncertainty, and then assessing the resulting mismatches between the total generation and the actual loads. This study will also assess the potential for system instabilities given the penetration of renewables.

### Justification and Goals

This project "[will develop, and help bring to market] advanced electricity technologies that reduce or eliminate consumption of water or other finite resources, increase use of renewable energy resources, or improve transmission or distribution of electricity generated from renewable energy resources" (Public Resources Code 25620.1.(b)(4)), (Chapter 512, Statues of 2006)).

This will be accomplished by:

developing scenarios over net loads and renewable availability. These scenarios must be internally consistent with the correct correlation between loads and generation. To ensure consistency between loads and generation in the initial phase of the project the contractor will base these scenarios on observed loads and renewable generation from past years. It is expected that the renewable generation data for past years will be partially based on observed generation data and partially inferred from available wind speed and solar data. Stochastic variations of the time histories will be generated.
Detailed Assessment of System Stability is another goal of this project, which is to evaluate grid stability under high impact conditions identified using enhanced models.