Intelligent Agents for Integration of Renewables and Storage Project Summary

The overall project goal of the CEC PIER funded, "Intelligent Software Agents for Integration of Renewables and Storage" was to demonstrate that applying agent technology could expand the potential delivery of renewable energy and use of existing transmission facilities for the benefit of the consumers in California. More specifically, the project objective was to address delivery of wind generation resources located in the Tehachapi wind resource area in California.

The Tehachapi area grid consists of a 66 kV sub transmission system that connects to a 230 kV system. Both the 66 kV and 230 kV systems are owned and operated by Southern California Edison (SCE). The Tehachapi grid currently has over 340 MW of installed wind energy generation and only approximately 80 MW of local load that is primarily concentrated in two large industrial users. VAR transport and voltage control are major considerations in weak grids such as Tehachapi. Coordination of VAR support provided by multiple wind farms with utility VAR resources or by storage assets with similar and additional capabilities is a significant consideration that is further complicated by the area's variable wind conditions. Coordination/control of local VAR assets therefore requires a level of distributed decision-making and control that could be a potential match for agent-based control technology. Improved voltage and VAR control has the potential of increasing the overall transmission capacity of the existing system, which would in turn fulfill the primary project objective.

The complexity of both the problem and the potential solution dictated a two-phase approach. In the first phase, the problem was characterized along with the requirements of the agent-based system that could address the problem. The second project phase then provided for installation of a Beacon Power flywheel storage system along with implementation and demonstration testing of the agent-based system. The demonstration test period officially began on December 1, 2010 at 4 p.m. and ended on February 11, 2011 at 5 p.m. Overall, the agent-based system performed well during the demonstration period, during which it successfully:

- Gathered and processed the needed 5 second SCE SCADA data achieving a 95.7% data collection rate,
- Achieved an overall, agent availability exceeding 99% during the demonstration period with the exception of one agent, which experienced lower availability due to outages of the cell modem based communications (unique to demonstration).
- The Bayesian Belief Networks (BBN) used by the agents to detect and predict abnormal system conditions operated successfully during the demonstration period. Two powerful BBN capabilities were demonstrated; first, was ability of the BBN to "learn" from actual operating data and the second was the ability to operate in the presence of unknown data.

- The Beacon Power storage system operated under agent control continuously during the demonstration period. The storage system operated in Frequency Regulation mode 97% of the time but was also successfully "retasked" to provide VAR support based on local system needs.

To summarize, this CEC PIER project was highly successful. During the project, the project team successfully identified a significant opportunity to demonstrate the feasibility of the agent-based approach. The system that was subsequently configured and implemented performed well during the demonstration although it was constrained by the limits of the initial modeling and configuration effort.

This project demonstrates, as previous projects have demonstrated, that the distributed decision making capabilities of an agent based system provides a robust and flexible control methodology well suited to the dynamic "Smart Grid" environment. This particular project involved distributed decision making as it relates to integration of renewable assets, storage and transmission system assets but past projects have demonstrated relevance to coordination of distributed energy resources such as distributed generation and curtailable loads at individual sites in response to dynamic pricing as well as coordination of actions between multiple sites.