CEC Funded Project Demonstrates Distributed Decision Making Potential for Grid Management

Background

Improved integration of renewable energy resources such as wind and solar power is one of the promises of the smart grid. The intermittent nature of renewables complicates the assimilation of these resources into the electrical grid requiring a large amount of local data gathering and processing in conjunction with timely decision-making. Intelligent agent software technology, where software processes the data, develops operational suggestions, and then implements those suggestions, has been identified by the Department of Energy (DOE) as a key element of the smart grid initiative.

The "Intelligent Software Agents for Distribution Management and the Integration of Storage and Renewables" project was successfully completed in June 2011. This project is the latest of three successful CEC PIER funded projects involving the use of intelligent software agent technology. In the first two projects intelligent software agents were successfully used to manage the operation of distributed energy resources (DER) in response to dynamic electric rates. The overall project objective of this latest intelligent agent based project was to demonstrate that applying agent technology could expand the potential delivery of renewable energy through integration with storage technology and improved management of existing transmission facilities. More specifically, the project objective was to address increased delivery of wind generation resources located in the Tehachapi wind resource area in California.

Project Description

During the project, the project team successfully developed an agent-based system that was installed and tested on a commercially ready hardware platform. The agent-based system was subsequently demonstrated over a 10-week period, during which it operated autonomously to:

- Gather utility SCADA information on Tehachapi area substransmission system assets,
- Forecast local wind generation,
- Develop recommendations for area

Left: Agent-Based Storage System Interface
Source: CEC PIER 500-07-020 Final Report
Right: Flywheel Storage System Tehachapi Installation
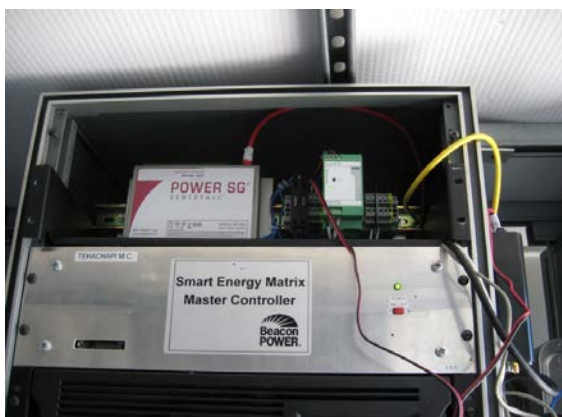
capacitor bank operation using a Bayesian Belief Network (BBN),

- Develop flywheel storage system operating commands, and

- Implement the resulting storage system operating commands via communication with a commercially available flywheel storage system installed in the region.

Example BBN Used by a SubTransmission System Agent
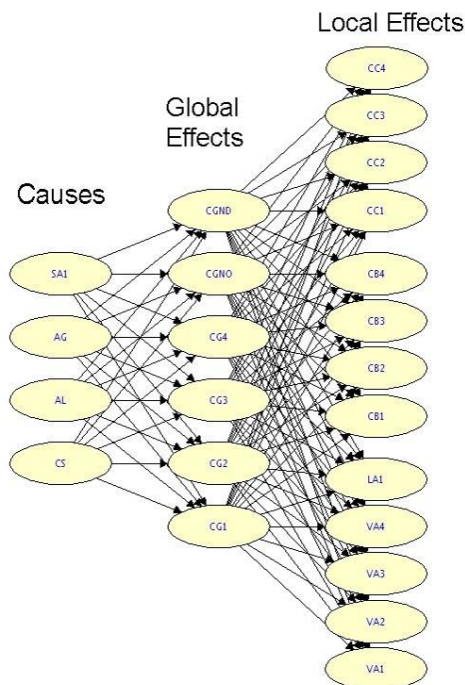
Project Results

Overall, the project was highly successful. The BBN model, which was used by the agents to detect and predict abnormal system conditions, performed well, and two powerful BBN capabilities were proven: the ability of the BBN to learn from real operating data; and its ability to operate in the presence of unfamiliar conditions. The results indicate that the dynamic operation of the system could have shortened the wind curtailment period for a curtailment event that occurred from December 10th to December 11th of 2010, if the intelligent agent system had been fully operational at that time.

The ability to derive multiple benefits from an energy storage system was also effectively demonstrated. During the demonstration, the flywheel storage unit was continuously controlled to provide either frequency regulation (normal operation), or to operate in a hybrid mode provide frequency regulation with modified reactive power output based on local needs. The agents, acting based on local information, were able to "retask" the storage system to provide local benefits in addition to routine frequency regulation operation.

AESC Services and Specialties

- **Advanced computing technologies**

- **Software development and implementation**

- **Demonstration project development and implementation**

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