DR17.18 – Demand Response with Variable-Capacity Light Commercial HVAC Systems

OPPORTUNITY

What was the project's purpose?

Variable-Capacity (VC) Heating, Ventilation, and Air-Conditioning (HVAC) equipment provides enhanced Energy Efficiency (EE) and customer comfort benefits over conventional fixed-speed equipment. For light commercial applications, Variable Refrigerant Flow (VRF) systems and packaged Rooftop Units (RTUs) leverage variable-speed components and complex controls to achieve superior part-load efficiency over conventional equipment. Numerous studies have been completed in recent years to assess the benefits of variable HVAC systems, which have become a valuable resource in utility EE programs.

Yet the variable-speed capabilities of these systems have not been fully leveraged for Demand Response (DR). With their on-board instrumentation and communications capabilities, VC systems are prime candidates for implementing both EE and DR functionality, potentially offering dual program participation. The implementation of DR control strategies that leverage the superior part-load efficiency of these systems could enable greater demand reduction or reduced impact on occupant comfort over DR with conventional fixed-speed HVAC systems.

This project sought to address this market gap by demonstrating advanced DR control strategies for VC air-to-air HVAC systems in light commercial buildings in SCE territory.

TECHNOLOGY

What technology was evaluated?

After outreach to several companies to partner in this project, a producer of variable speed RTUs (Manufacturer A) and a major manufacturer of VRF systems (Manufacturer B) agreed to participate. Manufacturer B, the VRF system manufacturer, implemented a conventional DR strategy and supported OpenADR 2.0b, as well as four advanced DR strategies:

- Change in thermostat setpoint temperature (conventional strategy).
- Limit equipment thermal capacity (and therefore electric power) subject to a maximum allowable deviation in indoor temperature.
- Change in temperature setpoint to increase capacity delivery ("load up" to enable pre-cooling).
- Targeted capacity reduction, where cooling or heating is turned off for specific zones to meet the target reduction based on zone priority.

SCE helped identify field sites for each technology in light commercial buildings that represent typical applications in their service territory, and one was selected for each technology (two total). Each site was instrumented with power monitoring and temperature sensors so HVAC system response and the impact on indoor temperatures could be analyzed in detail.

FINDINGS

What were the major findings?

For the VRF system, the findings of this study indicate that Capacity Limit control can reduce electrical demand with minimal impact on indoor temperatures. Additionally, The VRF system was found to respond as expected to commands sent via OpenADR 2.0b. As a result of participation in this study, Manufacturer B has integrated this advanced DR control strategy into a controller designed for commercial buildings.

For the variable-speed packaged RTU, Manufacturer A, while understanding the benefits of DR, was unable to implement advanced DR controls or OpenADR support during this project.

It would be advantageous to work with additional equipment manufacturers to expand the EE DR opportunity for this class of equipment. Several manufacturers are beginning to assess and implement these types of controls in their light commercial variable-speed products. These manufacturers are eager to provide value to electric utilities with enhanced DR capabilities but need assistance in implementing and testing the new controls.