Case Study: Field Evaluation of a High Efficiency RTU

BETTER BUILDINGS ALLIANCE

In 2011, the U.S. Department of Energy's Building Technology Office (DOE's BTO), with help from the Better Buildings Alliance (BBA) members, developed a specification (RTU Challenge) for high performance rooftop air-conditioning units (RTUs) with capacity ranges between 10 and 20 tons. Daikin's Rebel RTU was recognized by DOE in May 2012 as the first to meet the RTU Challenge specifications. A study was commissioned to compare the Rebel unit with a standard reference unit in the field.

The goal of the RTU Challenge demonstration was to estimate the seasonal performance of the RTU Challenge unit and the annual savings that can be achieved by installing the Rebel unit instead of an alternate standard unit. The demonstration took place at two grocery stores located in New Smyrna Beach and Port Orange, Florida.

The Rebel air-conditioner with gas furnace was installed to replace an existing unit in July 2013 at the New Smyrna Beach store. The Rebel unit has two compressors with one variable-speed inverter compressor, composite condenser fans, variable-speed electronic commuted motor fan motors, modulating hot gas reheat, MicroTech® III controls that can be integrated with optional BACnet or LonMark building automation systems, and electronic expansion valves.

The reference unit is an existing rooftop unit in the Port Orange store that is about 6 years old. The reference unit has two compressors for staged cooling and a constant-speed supply fan. Both units have the same rated cooling capacity of 7.5 tons and serve each store's office spaces with similar footprints.

Daikin Rebel Unit. Source: Daikin

Field Evaluation of the RTU Challenge Unit Results	
Host Name and Market Sector	Publix, Retail/Grocery Store
Energy Savings	16,000 kWh annually
Utility Costs and Savings	$1,600.00 annually (based on $0.10 per kWh electricity rate)
Simple Payback	3.8 year simple payback
Operations and Maintenance	The start-up, controller configuration, and commissioning of the Rebel unit was a challenge because the local distributor did not have experience with installing these new units. No maintenance issues arose over the course of the study.
Other Benefits	No comfort issues reported, either positive or negative.
Host Name and Market Sector	Publix, Retail/Grocery Store

Demonstration Process and Challenges

It was a challenge to find two units running in two different spaces that served similar cooling loads. Although two grocery stores with similar layouts were selected, the monitored data showed that they have noticeably different load profiles.

A set of sensors were used to measure the dry-bulb temperature and the relative humidity for the outdoor-air, the return-air, the mixed-air, and the supply-air. RTU total power consumption was also measured using a power transducer. The average daily energy efficiency ratio (EER) was then computed for each unit using the monitored data.

The Rebel unit had a higher daily EER than the reference unit for almost every evaluated day. The EER ratio increased as the daily average outdoor-air temperature decreases, as expected. The average of the daily EER ratio for all days is approximately 1.38, which means that on average, the daily EER of the Rebel unit is 38% higher than that of the reference unit.

Conclusions

Based on the comparisons of performance between the two units over the entire season, the Rebel had 31% higher seasonal EER compared to the reference unit. If the site chose to install a standard unit instead of the Rebel, it would have consumed approximately 16,000 kWh more annually leading to additional energy costs of roughly $1,600 based on $0.10 per kWh electricity rate.

The incremental cost reported by Publix for installing the Rebel was approximately $6,000, which translates to roughly 3.8 years in simple payback.

Learn More

You can learn more and take a look at the full RTU Embedded Diagnostics: Development, Field Testing and Validation report on the Better Buildings Alliance Space Conditioning page.

You can also join the Advanced RTU Campaign (ARC). ARC is an initiative supported by the DOE that encourages commercial building owners and operators to replace their old RTUs with more efficient units or to retrofit their RTUs with advanced controls.

Report # PNNL-23672; Weblink http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23672.pdf.

If you have any additional questions, please contact techdemo@ee.doe.gov