Emerging Technology Program

#1077: Dynamic Air Balancing System

Public Project Report

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Full Report

The following executive summary is made publicly available by Nicor Gas as part of their Emerging Technology Program (ETP). The detailed Nicor Gas ETP report is available to qualified state and utility run energy efficiency programs upon request. Please contact the Nicor Gas ETP administrator at [*NicorGasETP@gastechnology.org*](mailto:NicorGasETP@gastechnology.org) *to find out how to access the full report.*

Executive Summary

Introduction

The Nicor Gas Emerging Technology Program (ETP) assesses new technologies that have the potential to realize natural gas savings for the 2.2 million Nicor Gas customers in Northern Illinois. The ETP is part of the ongoing Nicor Gas energy SMART energy efficiency program and is delivered by the Gas Technology Institute (GTI). This report summarizes the findings to evaluate the tested dynamic air balancing system and its potential to provide energy efficiency to Nicor Gas small commercial customers.

Background

The automatic and dynamic zone damper (retrofit kit) system tested in this pilot is intended to provide comfort to occupants with additional, distributed room temperature control in small buildings. Smart dampers are operated by local thermostats providing individual zone temperature control. While not a true variable air volume (VAV) system, such zoning can provide energy saving benefits, if properly applied. Energy savings are achieved when the zone balancing technology effectively reduces the average zone temperature set point across the system. The manufacturer has claimed the system can provide 20-30% energy savings.

The system utilizes wireless thermostats, smart dampers, and a web-based controller for ease of installation, setup, and maintenance. The expanded control of the dynamic air balancing system proactively eliminates temperature excursions (rooms that are under or over conditioned). Smart algorithms to model the thermal envelope of the building reside on remote computer servers (i.e., cloud), predict heat loads based on daily weather and user settings, and preemptively direct thermal settings and damper positions to rebalance airflow without increasing backpressure and the need for bypass dampers. Advanced options include direct control of existing fan variable speed drives, occupancy detection, and demand-based ventilation using ASHRAE 62.1: Ventilation for Acceptable Indoor Air Quality calculations.

Disclaimer Note: Due to comfort complaints from building tenants during the pilot demonstration, the settings were adjusted to maximize comfort rather than efficiency for two of three tested operation modes.

Results

This Nicor Gas ETP pilot field study targeted two rooftop air handling units (RTUs) to evaluate the performance of the tested system's dynamic air balancing algorithm mode. The RTUs were located at a two-story office building in Skokie, IL. The RTUs serve roughly 6,000 ft^2 of divided office space on the second floor. One RTU serves 12 zones on the north side of the building (North RTU), while the other RTU serves 21 zones on the south side of the building (South RTU). In order to evaluate the performance and energy savings potential of the dynamic air balancing system, three operational modes were evaluated as outlined in Table 1.

Table 1. Three Operation Modes

	Baseline	Dynamic Air Balancing System Only	Dynamic Air Balancing with Demand Control Ventilation (DCV)
Operation Mode Description	Dynamic system zone balancing and DCV disabled	Dynamic balancing activated	Dynamic balancing and DCV activated. A software switch in the setup activated DCV control
Zone Dampers Position	Fixed corresponding to damper positions optimized by dynamic air balancing during peak cooling load	Proprietary algorithms modulated damper positions to achieve temperature set points	Proprietary algorithms modulated damper positions to achieve temperature set points
Outside Air (OA) Damper Position	Fixed to a minimum position	fixed to a minimum position	CO_2 sensor in the return duct to control the existing motorized OA damper as needed to maintain indoor air quality
Data Collection Duration	8 weeks	8 weeks	6 weeks

Data was collected in each of these modes over the course of the 2015/2016 heating season for representative heating degree day (HDD) periods to measure facility energy savings and validate manufacturer's claims. While the dynamic air balancing system has a number of specific control strategies, the primary focus of the Nicor Gas ETP study was on the zone balancing benefits.

Gas use for baseline and dynamic air balancing operation (dynamic system-only) was compared across the range of HDD. Gas use by the North RTU was reduced by 27% and by 25% for the South RTU. Dynamic air balancing with DCV operation provided an incremental energy savings, between 35% to 55% above the savings from dynamic system-only operation, which matches published data on DCV energy savings.[1,2] However, DCV energy savings results were not included in the economic assessment for two primary reasons: (i) the data set was significantly limited due to operational issues at the site, and (ii) the DCV controls settings for the dynamic system allowed for outside air (OA) dampers to be completely closed in violation of ASHRAE 62.1: Ventilation for Acceptable Indoor Air Quality.

Annual energy cost savings assume similar annual electricity savings as measured gas savings. Electric cost savings would include cooling savings as well as year-round fan savings. A natural gas price of $0.741/therm and an electric price $0.088/kWh were applied. The installed cost premium for the dynamic air balancing system includes the central controller for each RTU, and 1-2 motorized dampers and smart thermostat dampers per zone. Updated equipment costs were provided by the manufacturer, while installation estimates are based on actual costs for the demonstration. Although the energy savings of 20-30% are significant, with relatively low energy prices, high installed costs, and an annual software license, simple paybacks exceed 20 years for both RTU installations.

Despite a few trouble spots during the initial period, the demonstration site reported improved comfort levels with the dynamic air balancing system and site participants were generally pleased with the system performance. Other benefits include zone temperature control and a user-friendly portal to provide real-time data on zone and supply temperatures and RTU performance data.

This site likely represents the best case scenario for this technology due to the significant existing comfort issues caused by the operation of a single-zone system in a multi-zone application. Energy savings are expected to be lower when applied to HVAC systems that are more appropriately balanced.

[1] Hackel, S., et.al.," Energy Savings from Implementing and Energy Savings from Implementing and Commissioning Demand Control Ventilation", Conservation Applied Research & Development (CARD), Minnesota Department of Commerce, Division of Energy Resources, COMM-20130501-72625, July 2015.
[2] "Using Demand-Controlled Ventilation to Reduce HVAC Costs", © 2005 E Source Companies LLC, http://bea.touchstoneenergy.com/sites/bea/files/PDF/Tech/UsingDemandControlledVentilationtoReduceHVACCosts.pdf.