Re-tuning Case Study

Parmenter Re-tunes Las Colinas Tower for Significant Energy Savings. Irving, TX

ENERGY STAR score improves by nine points with Building Re-tuning training.

Address: 225 E. John Carpenter Frwy, Irving TX
Owner: Parmenter Realty Partners Size: 349,436 sq ft.

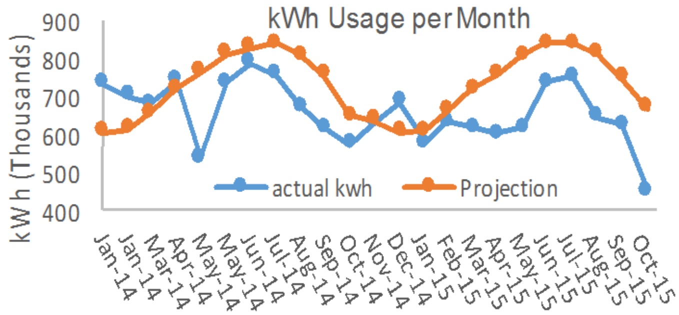

Figure1. Projected kWh usage based on a year's monthly consumption prior to re-tuning and weather normalization.

As a member of the Better Buildings Challenge, Parmenter Realty Partners is constantly looking for ways to improve their sustainability and reduce the impact their buildings have on the environment. Building re-tuning provides an opportunity to reduce energy consumption across the company's portfolio. In January 2014, with training experts from the Pacific Northwest National Laboratory (PNNL), Parmenter re-tuned its Las Colinas Tower II building in Irving, TX. Re-tuning provided the facilities management team with the ability to identify and understand building scheduling opportunities that drove significant, low-cost energy savings.

In the 2 years post-re-tuning, the building has saved an average of 9.7% on its electricity usage due to a long list of energy savings opportunities (details shown on following pages (Figure 1). Las Colinas Tower II also improved its ENERGY STAR score by 9 points from 70 to 79.

Initial implementation of re-tuning measures led to the discovery of additional efficiency opportunities. First, Parmenter adjusted the outside air temperature sensor placement so it would read more accurately. Once the temperature sensor was calibrated, the operators realized that their BAS program contained numerous additional overrides. The more the Las Colinas building engineers investigated the root logic of BAS operations, the more opportunities they identified. Over the span of a few months, Parmenter implemented over two dozen no- to low-cost re-tuning measures and is continuing to re-tune Las Colinas II periodically for persistent savings.

What is Building Re-Tuning?

Building re-tuning is a systematic process to identify and correct building operational problems that lead to energy waste. Building Re-Tuning Training is a blend of building walk-throughs and classroom instruction that teaches building operations staff and service personnel how to save energy and increase occupant comfort through low and no-cost operational improvements. There are two versions of the training: Observation-driven re-tuning for buildings without a building automation system (BAS) and data-driven re-tuning for buildings with BAS. This case study utilized the data-driven protocol.

No- and low-cost savings opportunities include items such as replacing faulty sensors, adjusting set-points and inefficient schedules, utilizing variable speed fans and economizers, insulating pipes, adding CO2 sensors, widening thermostat dead bands, and sealing building envelope leaks. This process can reduce building energy use up to 25%.

Building re-tuning saves energy and money

From late 2013 to early 2015, PNNL helped identify re-tuning measures in 100 office buildings. Many, but not all, of the recommended measures were implemented by the building operations staff. Annual energy savings ranged between 2% to 26%, with a median savings of 15%. Annual normalized cost savings ranged between 0.0$/sf to 0.6$/sf, with a median savings of 0.12$/sf. If all re-tuning measures identified were implemented, the savings would have been even larger.

Example: Re-tuning Opportunity to Adjust Negative Building Pressure & Reheat Inefficiencies Found in BAS Trend Data

In Figure 2, the mixed air temperature (green line) and return air temperature (blue line) trended data readings both show patterns that may indicate the building is operating in a negative pressure condition at night (and perhaps even during the day). After the supply fan shuts down, both the mixed air and the return air temperature sensors immediately drop toward the outdoor air temperature value (teal line), in some cases dropping as low as almost 40 F.

It appears that during the 6-day period in November, the return air temperatures progressively got cooler (possibly indicating that this building also got cooler). Perhaps the reheat system is not working properly, or some other issue exists such as significant infiltration. This is a re-tuning efficiency opportunity that should be explored further to solve the root-cause of the data finding in Figure 2.

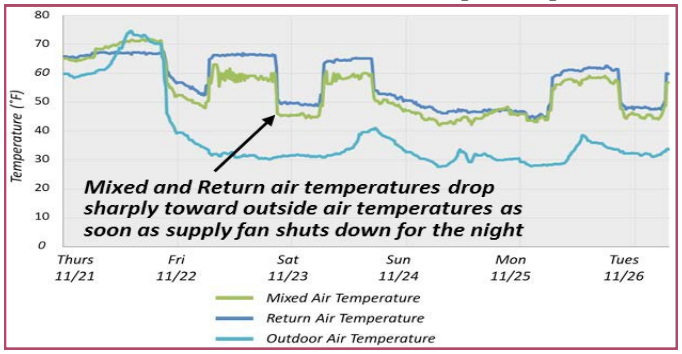

Figure 2. Trended Data Showing Return Air and Mixed Air Temperature Performance

Table 1. Sampling of Re-tuning Measures Implemented for the Las Colinas II

Issue Area	Finding	Solution	Cost
Limited interaction with BAS by Engineers	Engineers were not internally trained to make changes to the BAS, relying heavily on the BAS vendor	Staffing was not 100%; need to hire a chief engineer with strong BAS experience. Plan training for engineers to properly use the system and make adjustments.	Within the property budget
Trending setup and monitoring	Trended data is invaluable for proper operation of the building	Trained engineers and now expect them to trend regularly	$0
BAS Vendor evaluation	Existing BAS vendor was not qualified to re-program the system, only to make minor adjustments	Replaced vendor	$0
Reprogram BAS	BAS programming has been compromised over time and new vendor couldn't make small cost effective changes without effectively rewriting	New control vendor completely re-wrote new control logic (optimized older program logic in the process)	$18,000
Airflow around CHW coil	During the field walk down, found air leakage due to gaps around the CHW coils	Installed sheet metal at open gaps to funnel the air through coils	$4,000
Calibration of pneumatic devices	A large percentage of pneumatic devices were out of calibration and water had been introduced into the system; the filter for air dryer was plugged up (O+M).	Recalibrate all pneumatic devices, add gauges to the air dryer, add more monitoring points to BAS for pneumatic system, train engineers on new HVAC tracking form for hot/cold calls	$17,000
Preventive Maintenance of dampers	Found that most dampers were dirty, gaskets are either missing or worn out, operation needs to be verified	Perform preventive maintenance on dampers and make all identified repairs. Make sure they operate properly per BAS program	In-house

Example: When Window-to-Wall Ratio is Significant, Re-tuning Opportunities Exist in Solar Load Efficiencies

The window-to-wall ratio is significant (at least 80% or greater) in Las Colinas Tower II, meaning that solar loading significantly impacts the building. Using a thermal imaging camera (see Figure 3), a significant difference in window temperatures on the south and west sides of the building was identified. East, south and west-facing windows exhibit significant solar gains on cold, but clear days (morning low temperatures around 20 F, afternoon high temperatures around 45 F). This was creating interior temperatures between 75 F and 78 F at the perimeter spaces facing south. Re-tuning measures to consider for buildings to counter solar heat gain include:

- Send periodic messages to occupants via email to encourage the judicious use of window blinds during peak solar conditions.
- Turn perimeter lights off (where controls and switching allow) to reduce the heat gain from electric lighting loads (trade off the solar gain with the lighting heat gain or vice versa) or de- lamp where possible.
- Window tinting may be an effective investment, but should be carefully evaluated for correct tinting materials and installation methods to safeguard windows from damage

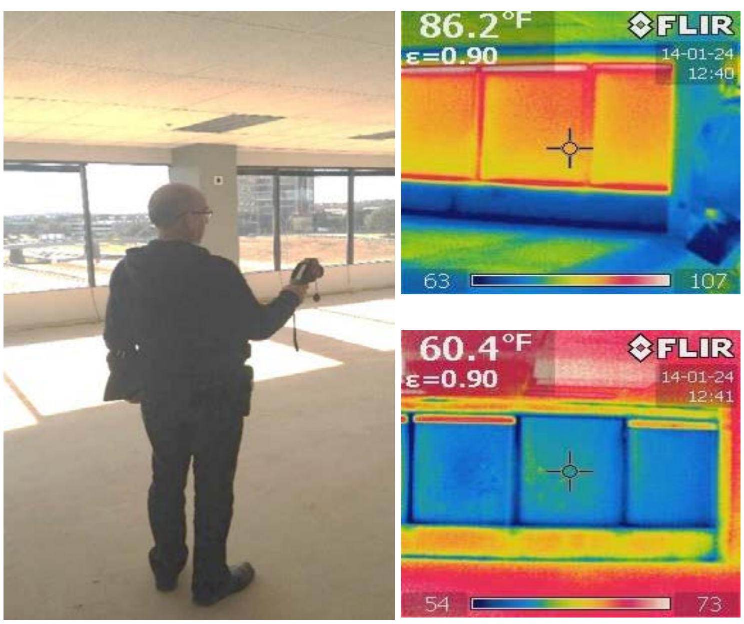

Figure 3. A thermal imaging camera is used to identify solar load for south-facing (top) and west-facing (bottom) windows

Strategy for Success: Don't Rely Solely on your BAS. Walk Down the Building Too

Building engineers sometimes rely too heavily on BAS alerts and not enough on in-person building walk-downs. While sophisticated BASs open up many possibilities for identifying efficiencies, some efficiency opportunities can only be identified from the physical act of walking through the building.

Building walk-downs help operators to get to know the building better and develop a general impression of the overall building condition, building systems, and HVAC system performance.

The major steps of a building walk down include:

- Review electrical and mechanical prints
- Walk the outside of the building
- Walk the inside of the building
- Walk down the roof
- Walk down the air handlers
- Walk down the plant area
- Review the DDC system (BAS) front end

After the re-tuning training, the Las Colinas team decided to walk-down the building after hours. Operators found numerous inefficiencies: heat on after hours, task and break room lighting on while space was unoccupied, and terminal air fans running.

To solve this, they asked security to turn off all lights left on by tenants, and proposed installing electric to pneumatic (EP) switches on every floor to shut off all non-essential loads after hours.

Figure 4. Building walk-down included checking above the ceiling for duct condition, etc. (left) and reviewing electrical and mechanical prints (right)

Example: Re-tuning Opportunity Identified in Las Colinas II Loading Dock Ceiling

Figure 5 shows an infrared image of the Parmenter Las Colinas II loading dock ceiling, just below office space. The outdoor air temperature is 30 F while the ceiling temperature was measured much higher at 43.3 F. During the re-tuning training building walk-down, it was noted that the loading dock ceiling insulation may be lacking. This likely has resulted in heat loss/gain to the office spaces above, which could contribute to tenant hot/cold calls and energy inefficiencies.

Re-tuning opportunities include evaluating areas of missing insulation or poorly insulated/sealed locations in loading docks, parking garages, and similar areas open to the outdoors.

Such measures include:

- Verify that initial garage parking lot area under office spaces is adequately insulated (hard ceiling with access panels). Suggest using an infrared camera image of the floor from above (looking down) if access issues are a problem.
- Seal penetrations of conduits and piping that route from loading dock areas into the building.
- Look for similar penetrations that may not be sealed on all perimeter sides of the building

Figure 5. A thermal imaging camera is used to examine the loading deck ceiling

Example: Problem with Manual Override of a BAS and Re-tuning Solutions

In Figure 6, the AHU discharge air temperature set point (blue line) appears to be manually adjusted, based on the staggered stair-step flat lines. The discharge air temperature set point in the control code was found to be reset automatically from the return air temperature with a secondary reset based upon the outside air temperature. Figure 6 hints at manual overrides being used, so perhaps the automatic reset values are too low.

Retuning Solutions:

- Use a return air temperature reset only (remove the secondary outdoor air temperature reset). The current reset operation is configured to reset between 70 F and 74 F return air temperatures, but the reset should be based upon the return air temperature operating between 72 F and 76 F. This schedule will lead to more comfortable conditions and will decrease the need for occupants/tenants to request overrides of the system schedule
- Reset the discharge air temperature (blue line) to be between 53 F and 63 F, a 5 F increase. The current operation is between 48 F and 58 F. With this increase, the supply air should still be cool enough to provide adequate cooling at the warmest zones and provide adequate moisture removal at the cooling coils. The existing reset parameters result in higher energy costs for cooling and subsequent reheating at the terminal boxes

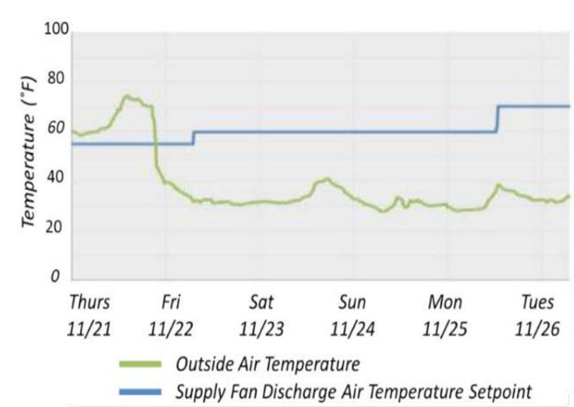

Figure 6. Manual Override on AHU Supply Fan Discharge Air Temperature Set Point

Why Invest in Building Re-Tuning Training?

Building Re-Tuning Training is a worthwhile investment because saving energy is not reliant on commissioning agents, energy auditors or professional engineers. Facility engineers and building operators - the people who are in the buildings regularly – learn to identify energy saving opportunities and act. The savings are regenerative because the trained building operator or facility engineer is able to continuously re-tune his/her building and maintain optimized conditions.

Summary of implementing re-tuning measures:

After the first re-tuning was completed by PNNL, Parmenter installed smart meters with Mach Energy so they can easily monitor how the building is performing in real time.

Capital improvements that have impacted building energy consumption since the original re-tuning are:

- Installed baffles around the chilled water coils where air was bypassing around the surface of the coil to direct air across the coil
- Replaced defective chill water bypass valve
- Added inlet and outlet gauge on the pneumatic system and an alarm to notify the staff to clean the chilled water coils
- Cleaned the chilled water coils
- Rewrote the BAS program and completely retired the old program that was causing problems with the operation of the plant
- Monitored and adjusted the start times on the chiller, AHUs and other related equipment in the chiller plant
- Added/replaced door weather stripping
- Adjusted the static pressure in the building

Key actions the company took for re-tuning are:

- Purchased infrared cameras to help assess the envelope
- Improved building O&M
- Hired qualified engineers to run the building
- Applied BRT to additional facilities

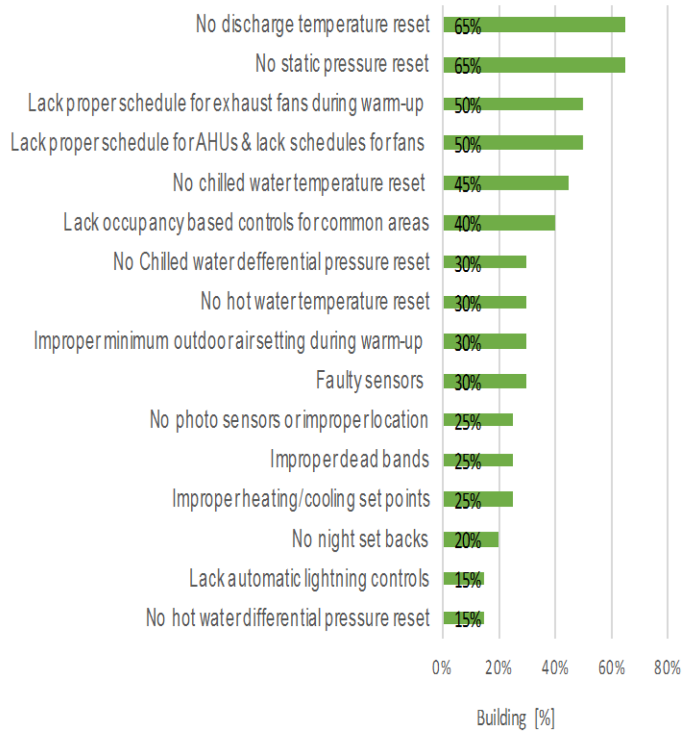

Figure 7. PNNL Meta-Analysis of 100 Commercial Office Buildings (2013-2015)

How to read this chart:

As many as 50% of the buildings in which re-tuning took place lack proper schedules for AHUs and/or lack schedules for exhaust fans running during warm-up mode; over 65% of the buildings do not use static pressure or discharge temperature reset on AHUs; over 30% of the buildings have one or more faulty sensors and/or improper minimum outdoor-air setting during morning warm-up, etc.

Acknowledgements:

This case study and related work is funded by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. Pacific Northwest National Laboratories created the building re-tuning training program and performed the building re-tunings for this case study. The Pennsylvania State University updated the results in 2016 with actual building performance data.

Re-tuning Training Opportunities and Online Resources

The Department of Energy funded Pacific Northwest National Labs (PNNL) to create the Building Re-Tuning Training program. Penn State led efforts for DOE to make Building Re-Tuning Training widely accessible. See https://www4.eere.energy.gov/workforce/projects/buildings-retuning-training for information about accessing the training. Classroom training material, training instructor manual and online re-tuning interactive training and energy charting and metrics tools are available at http://buildingretuning.pnnl.gov/