Industrial Application of Total Performance Oriented Retrofit

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ABSTRACT

With the significant HVAC savings generated by implementing Total Performance Oriented Retrofit (TPOR) technologies, facility owners and managers can create quick positive cash flow for equipment upgrade and retrofit or even scaling up the program by carefully selecting a pilot site. This article demonstrates through case studies how to take advantages of the innovative technologies and make the energy efficiency (EE) project or program happen with limited budget.

Keywords: Continuous Commissioning, Total Performance Oriented Retrofit, Integrated Dynamic HVAC System Optimization

Improving HVAC system operation and maintenance is becoming increasingly important in achieving LEED certification for existing buildings in light of the current green movement to conserve energy. Building commissioning has emerged as the preferred method of ensuring that building systems are installed and operated to provide the performance envisioned by the designer. Among all the commissioning methods Continuous Commissioning (CC) has been well accepted and acknowledged by DOE and some NGOs. Continuous Commissioning focuses on improving overall system control and operations for the building, as it is currently utilized, and on meeting existing facility needs. It goes beyond an operations and maintenance program. It does not only ensure that the systems function as originally designed, but also ensure that the building and systems operate optimally to meet the current requirements.

Retro-commissioning is a systematic method for investigating how and why an existing building's systems are operated and maintained the way they are, and identifying ways to improve overall building performance. Total Performance Oriented Retrofit (TPOR) is a process of combining CC with necessary innovative retrofit strategies in order to reduce total capital costs, payback of retrofits while producing state of the art facilities that operate at the maximum efficiency. TPOR focuses on introducing innovative retrofit technologies to maximize operational efficiency and minimize peak demand with reliable and state of the art equipments. In other words, designing retrofit or upgrade projects with innovative strategies you could make the projects feasible by realizing the great HVAC savings first.

Oftentimes the decision makers of corporate real estate, facility operation and maintenance, and public organizations face the same challenge that ideas and plans are constraint by available funding and the innovative technologies and approaches are atypical for their normal procurement procedures. Variety of building types and functions with different types and levels of control systems and mechanical components make their selection of starting an energy efficiency program even more difficult. This article consists of two case studies that demonstrate how some of the innovative technologies are utilized in commercial and industrial facilities to improve system reliability, IAQ, and reduce energy consumption significantly with measured results. The article also shows how to create a self funded project or program by leveraging the significant savings at project level or program level. Taking advantage of patent technologies we can make the capital project feasible in very short period.

A high-tech firm had control issues with their corporate headquarters. The site is a 1.2 million ft^2 multi-building complex consisting of offices, labs and a data center. Heating and cooling for the entire facility is supplied by an on-site Central Utility Plant with an all –air distribution system. In total, the HVAC system consists of 4,200 ton-capacity chiller, 100 single-duct AHUs, 50 single-zone AHUs, and 72 fan-powered boxes for perimeter heating. As they began their efficiency program, there were three primary goals: (1) Improve system reliability and maintainability, (2) Reduce peak demand, and (3) Reduce total energy consumption. The company was experiencing an 8MW peak every year and forecasted a 10MW peak for 2007 for which they did not have capacity. They chose to bring in an outside firm licensed to perform Continuous Commissioning® and TPOR. –During the course of 8 months in 2007, the two companies worked together to implement some unique and customized technologies such as a complete system Variable Water Volume control algorithm for the central plant which reduces primary pump power by 50% to 90%, reduces condensing pump power by 40% to 70%, and reduces chiller electricity consumption by 5% to 20%. Additional technologies include some of the following components: (1) single loop operation in an existing primary and secondary setup. This process reduces primary and condensing pump power in a range of 40% to 85% and increases chiller efficiency by 5% to 15%; (2) optimal chiller sequencing programming to ensure the entire chiller plant is working at maximum efficiency; (3) optimal differential pressure reset to eliminate control valve hunting, minimize mechanical energy waste in pipes, maximize the pump efficiency, minimize/eliminate valve over pressurization, and prevent pump over-heating or over-loading; (4) optimal supply water temperature reset to ensure excellent humidity control and maximum chiller efficiency; (5) the 60-80% rule to ensure safe chiller system operation and minimal total cooling system (compressor, pumps, and cooling tower) energy cost. There were also a collection of measures for AHUs and thermal storage systems such as optimizing the charging and discharging sequences to achieve a constant load profile during the entire day. Upon completion of the implementation, the site had significantly increased comfort levels, a state of the art facility with significantly more automation and a peak demand reduction of 1.7MW (Figure 1). Additionally, their annual electricity consumption was reduced by 4.5 million kWh (Figure 2).

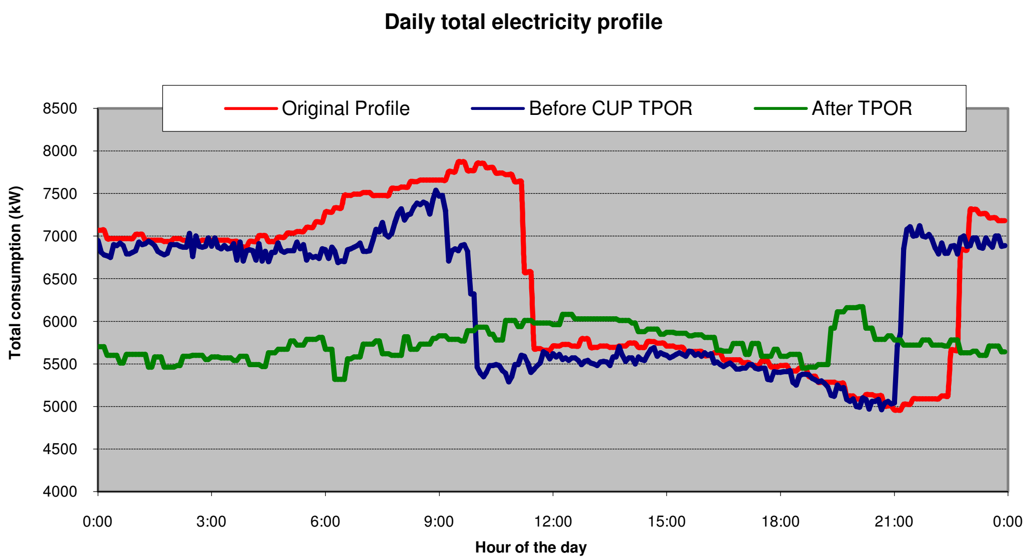

Figure 1. Daily total electricity profile for the corporate headquarters of a high tech firm

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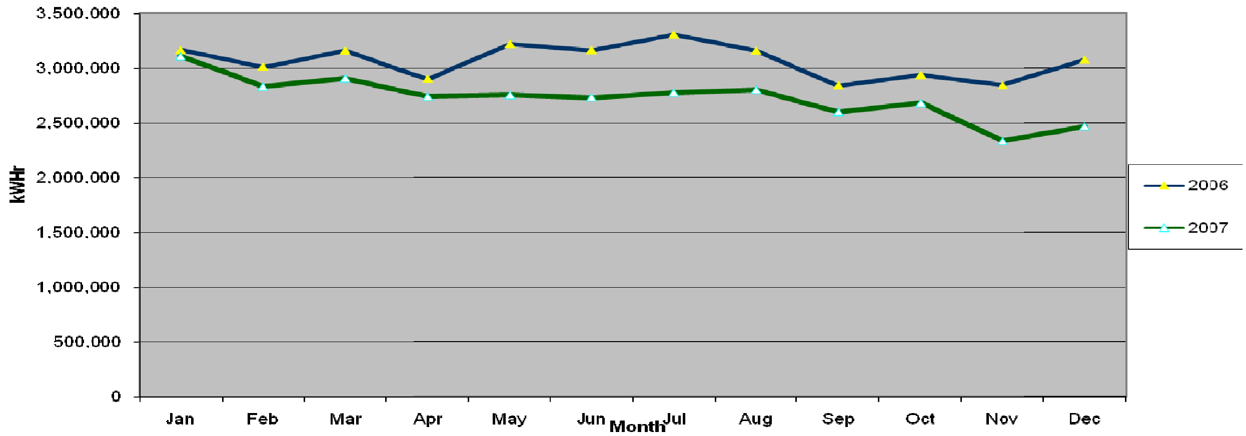

Figure 2. Monthly electricity usage comparison

The factored 1.7 MW peak demand reduction postponed the power system upgrade, which may cost the company $3 to $5 million. The actual total project cost is only a fraction of the power system upgrade cost. The company not only realizes significant comfort improvement, utility consumption reduction, as well as O&M cost reduction, but also has a complete set of state of art equipment which is very easy to maintain. Fortunately this project does not need too much justification to approve. However, the variety of measures and options allow us to customize our services into different categories based on different approval criteria: (1) Minimal initial capital cost - A facility with full DDC controls and installed Variable Frequency Drives (VFDs) on the majority of their fan and pump motors would be a good candidate. In this case, the initial project cost is only Bes-Tech engineering service fees, which are minimal, compared to mechanical equipment purchases. The savings range for this scenario is typically 10% to 30% of the HVAC consumption. (2) Maximum return on investment - Facilities with some DDC controls and a few VFDs, but with a centralized chiller plant and air handlers, are also good candidates for significant energy savings. In this scenario, the initial capital cost will be higher due to the need for retrofit purchases but the increased energy savings with generate a faster return on investment which is typically less than 24 months. (3) Maximized savings - Facilities with pneumatic controls or no controls and packaged roof top units or DX units can generate much higher savings opportunities. The projected energy savings for this type of facility is typically 60% to 80% of HVAC consumption. However, the capital cost will be higher due to the significant amount of retrofits required. Bes-Tech's innovative technologies can reduce the typical industry payback of this type of project from 10 years to less than 4 year.

The following example shows a program can actually start from a carefully selected one building and then extend to the rest of the buildings in a site or even in a single building a project can start at unit level and expand to a central plant. Bes-Tech engineers performed assessment at a pharmaceutical plant with multiple buildings all fed by the same Central Utility Plant (CUP). After the analysis the work began building by building saving the CUP for last (Opportunity in the Plant increases significantly when it is not overcompensating for inefficient buildings). One example of this was readily apparent in a two-story office/lab building with Stability Lab. The building is only 33,000 ft^2but it was a significant consumer of steam and electricity. There's one Single Duct VAV AHU feeding this building with 11 fume hoods and 2 exhaust fans. There're total 41 variable air volume (VAV) and 11 constant air volume (CAV) terminal boxes, and 28 exhaust boxes. The TPOR firm began by ensuring the Terminal Boxes for the first AHU were functioning properly. They then measured consumption for the associated Air Handling Unit for one week. Based on the analysis they performed for the facility and utilizing the prior twelve months utility bills as a baseline, they were able to develop a custom algorithm for they AHU, which was tested and qualified by the necessary parties for this very stringent environment and then implemented. The unit was monitored for another week. The results of steam flow for this single AHU were reduced significantly, which can be seen in Figure 3.

As you can see, savings is significant simply by customizing solutions for every component based on the actual load conditions. When all was said and done, this small building had a total consumption reduction of 82%. Obviously, these results are extraordinary but it all adds up and if done correctly, it is not uncommon to see a 20-50% reduction of total consumption for your facilities.

The next natural question is: How do I maintain the savings? The answer while obvious is not always easy to come by: "Buy In." Everyone from the site maintenance personnel to the facility and energy manager must buy in to the concepts. How is this done with unique, not necessarily common technologies? The only means to producing the best results is through the age-old process of perseverance and team work. The company you choose to partner with for this work must take the time to explain the ECMs identified; how they will be implemented; how they will work and what they will guarantee to save. Additionally, they must provide the necessary workshops or training to ensure changes can be maintained and won't be arbitrarily changed back because someone is frustrated or looking for a quick fix to a problem. No firm can come into your business and simply tell you what to do. The ability to trust and collaborate will be your company's key to success. Whereas reducing your consumption and becoming the hero for you company, just might be the key to that new Hybrid you've been eyeing…

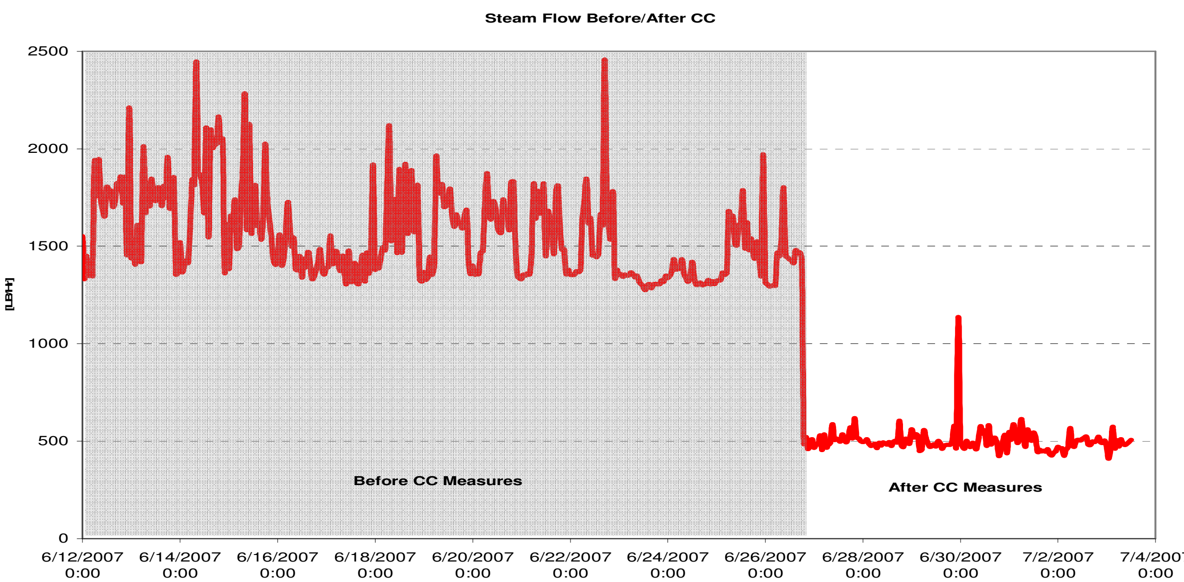

Figure 3. Trended steam flow consumption before and after CC

As long as the savings can be validated and verified, it is very possible to create a positive cash flow with no budget or minimum capitals upfront. It is feasible that an EE project or program can be scaled up with no budget or minimum capitals providing we carefully select a pilot building or site.

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