How the Culture of Inefficiency is Out-Foxing LEED, ASHRAE, and Efficiency Programs in the Midwest

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ABSTRACT

Energy efficient and LEED-certified buildings have gained popularity in the Midwest. However, there are many design and implementation deficiencies preventing achievement of the intended energy efficiency savings. Due to the complexity of modern building systems, the attention to detail required for their installation, and a culture of inefficiency among designers and contractors, energy efficiency features are commonly implemented incorrectly, resulting in not meeting energy savings goals.

This paper discusses real, yet anonymous, green buildings in the Midwest and the energy efficiency implementation flaws repeatedly preventing them from achieving their intended energy goals. The material is based on years of building commissioning and energy auditing throughout Ohio and surrounding states. The issues of focus are not isolated problems, but rather reoccurring problems encountered in many of the facilities we have worked with. In fact, some technologies we have never seen correctly implemented without heavy corrective guidance from our team.

This paper's objective is to display common weaknesses existing in the process of implementing energy efficient technologies and point out the necessary preventative steps that are often missing or rushed in the design/construction process. Examples of issues briefly discussed in this paper include inappropriate applications of condensing boilers, incorrect installation of demand control ventilation, ineffective variable frequency drives on pumps and fans, poor HVAC system type selections, area over-lighting and unusable ice storage systems. Where available, the increased energy consumption values will be provided, resulting from incorrect implementation. This information is valuable for green buildings in the Midwest and beyond to meet society's energy efficiency goals.

Introduction

Midwest states currently lag behind both the Northeast and West Coast regions in energy efficiency by a significant amount. A 2009 study conducted by the Rocky Mountain Institute shows that California and the top performing New England states generate over twice as many gross domestic product dollars per consumed kilowatt-hour as Ohio and its surrounding states. It should be noted that this study used data normalized to account for differences in climate and economic composition (Mims et. al. 2009). One reason for this is that the Midwest also lags in energy efficiency mandated programs, which are just now starting to arrive. For example, the ACEEE 2011 State Energy Efficiency Scorecard ranks Ohio's policies 24th, with contiguous states ranking 17th, 25th, 32nd, 37th, and 44th (Sciortino et. al. 2011). As a result, the Midwest also lags in energy efficiency culture and understanding. However, momentum is building behind energy efficiency programs throughout the Midwest thanks to emerging government mandates and rising popularity of building certifications like, LEED and EnergyStar. This mounting enthusiasm for energy efficiency comes with growing pains as the desire to implement it can outpace the ability of the region's building designers, installation contractors, efficiency program managers, and building owners to understand it and correctly apply it. The consequences of this lead to well-intentioned money being poorly spent on energy efficiency technologies that are inappropriately specified or incorrectly installed, leaving them ineffective. This paper is based on our company's real experiences with building energy efficiency projects in the Midwest. It details specific technologies that we commonly find are poorly selected, designed, or installed. It also explains some of the practices that lead to these issues.

Not only are energy efficiency implementation mistakes being made, but these mistakes are being adopted as common practice and slipping past overseeing groups, such as the US Green Building Council (USGBC). In 2009, the USGBC realized that 53% of their buildings certified through 2006 were not achieving Energy Star label status, based on their measured energy consumption. Furthermore, 15% of these LEED certified buildings were actually performing in the bottom 30% of the comparable national building stock on an energy-per-square-foot basis (Navarro 2009). As an energy efficiency consulting company that conducts building commissioning, energy auditing and efficiency measurement and verification work, we have had the ability to observe a wide range of newly constructed and retrofitted buildings throughout the Midwest. Through our work we feel we have a perspective from the front lines of why buildings are not performing as intended, and how they are out-foxing standards and checks put in place by organizations, such as USGBC, ASHRAE, government and utility programs.

How Inefficiency Gets Implemented

In general, energy efficiency technologies are difficult to implement. Building systems are highly interactive and complex. It takes knowledgeable engineers and contractors to properly identify where different technologies are appropriate and how to properly integrate them into buildings. Consulting companies, like ours, use engineers with graduate degrees who are trained and paid to specifically worry about energy efficiency. After years of studying these systems, even the experts are still learning how these systems should best be applied and installed to achieve optimal efficiency. Given the complexity of some energy efficiency investments in buildings, there are multiple ways for mistakes to be made and for inefficient buildings to sneak past the check systems of efficiency programs.

Poor energy efficiency implementation often begins with poor technical understanding or inattention by building owners and designers. Building owners cannot be expected to fully understand the different energy efficiency technologies available to them and how to properly select them. This is why design firms and consultants are hired. Without proper guidance, an efficiency-ambitious building owner may quickly spend money on the first vendor that talks to them. For example, a school system we worked with purchased two hot water condensing boilers costing over $90,000, based on our estimations from RSMeans 2011 Mechanical Cost Data. These condensing boilers were applied in a building system that did not allow them to condense and therefore, the new boiler system was only slightly more efficient than the existing system. The performance contracting firm estimated annual savings of over $16,000 per year, but actual savings will be less than $5,000 per year. Thus, the simple payback of this project is around 18 years. This school had many other areas they could have invested that money that would have dramatically reduced their energy bills. However, the owner was not able to understand the potential savings on their own or double check the accuracy of the contractor's questionable savings calculations. Over the years we have seen many building owners coerced into making bad investments in energy efficiency.

Selecting the correct efficiency technologies and ensuring they get correctly installed requires experience and attention. Approaching building designs with an energy efficiency objective requires design teams to challenge their old practices and invest time and effort into developing new approaches and intellectual infrastructure. In most cases it is necessary for designers to disregard their old design templates and practices that developed without efficiency in mind and to assess the energy efficiency performances of multiple system options and perform cost benefit analyses.

As enhanced commissioning agents in the design phase of buildings, we help to push for these changes and contribute to the cost benefit analyses of different efficiency options, but we are often met with resistance. Many firms try to hold on to their old methods and practices. Some of these poor practices include excessive system over-sizing and applications of old, familiar inefficient equipment. Some examples of excessive system over sizing are described in more detail in the Case Studies of Poor Efficiency Implementation section of this paper for both lighting and ventilation. However, an example of applying old, yet familiar inefficient equipment can be seen in a school we audited that recently received a brand new constant air volume dual duct HVAC system. This system type is inherently inefficient, developed in the 1970's as an early way to create multizone HVAC systems with simultaneous heating and cooling. This technology, as a new install, is generally banned by code in areas of California (E Source Technology Atlas Series 1998). However, it is not banned in Ohio and this design firm applied it to a school renovation. Despite this system, the school was able to receive Ohio State House Bill 264 financing, because little scrutiny is conducted by the state over the efficiency retrofits, and the total savings from all of the school's retrofits are lumped together, so distinguishing the bad investments from the good is difficult. Ohio State House Bill 264 financing allows schools to better fund energy efficiency projects within acceptable simple paybacks.

Another common practice we see in green buildings is for designers to simply specify equipment and systems that are marketed to be green without actually understanding their appropriateness, cost effectiveness or functionality. There are examples of this discussed in detail in the Case Studies of Poor Efficiency Implementation section of this paper.

How Inefficiency Out-Foxes Energy Efficiency Programs

After bad designs and implementations have made their way into a green building, these errors often sneak their way through reviews by organizations, such as USGBC or utility company efficiency rebate programs. These programs are capable of being duped for multiple reasons.

For example, the typical way for LEED buildings and rebate efficiency programs to assess relative energy savings in new construction is to utilize ASHRAE 90.1 standards to set a baseline scenario for building systems. ASHRAE 90.1 is a very useful tool built on years of development and knowledge. However, it is only a set of general baseline standards and cannot cover all the variables that greatly impact the efficiency of a building. Building designers and energy modelers cannot rely solely on ASHRAE 90.1 and must use their own expert judgment to address all system variables.

Often building energy simulation models are used to estimate the energy savings potential of building designs and systems. For example, most LEED certifications require an accurate energy model be created and submitted for review to determine if the building meets the required energy performance against the ASHRAE 90.1 baseline. However, accurate energy modeling takes years of experience and advanced understanding of building energy systems and thermodynamics. There are so many important details that must be input into a model that it is virtually impossible for an organization, such as the USGBC, to fully inspect each model. It is not a stretch for any modeler to intentionally or unintentionally skew the energy savings of a model in ways that a model reviewer would have difficulty finding.

Even if the model is created with 100% accuracy, a building that exceeds ASHRAE 90.1 baseline is not necessarily an energy efficient building. We reviewed the energy models of a LEED certified school located in Ohio. In this project, the baseline energy model appeared to be correctly created according to ASHRAE 90.1-2007 guidelines and the proposed building exceeding the energy savings by 40%. Yet, if we were to treat the baseline energy model as a real building and enter its information and performance into EnergyStar Portfolio Manager, the baseline building only performs in the low 40 percentile range. Thus, the baseline building is below average in energy efficiency, relative to other existing buildings.

Another reason poor energy efficiency projects can occur is because often measurement and verification is not required and nobody is held accountable for actually delivering promised energy savings. In most efficiency scenarios, measurement and verification is more complicated than simply evaluating energy bills. It typically requires a team of third party, unbiased engineers to conduct the measurements and distinguish the energy savings achieved. For LEED certification, buildings are currently not required to receive measurement and verification of energy efficiency performance. However, this may be coming in the near future. LEED does currently provide credits for owners who opt to have their building’s efficiency measured and verified.

In Ohio, many of the energy efficiency rebates from public utilities require measurement and verification. This is a good practice, but cannot feasibly be performed for every efficiency project. Thus, prescriptive rebate programs are also created which offer rebate incentives for simply purchasing certain equipment, based on a set “deemed” savings value. Some of the prescriptive measures can offer inappropriately high incentives for technology based on unrealistic energy savings claims. For example, many of the Midwest utility programs rely heavily on linear T12 fluorescent to T8 change-outs. In Ohio, savings for this type of project are based on the Ohio Technical Reference Manual (TRM). Consider that even though this is one of the most common efficiency projects in the program portfolio, the savings estimates are extraordinarily flawed for several reasons, including:

- A stated measure life of 15 years, even though it is known T12s are to be regulated out of existence within a few years resulting in realized savings of only 3-5 years;
- The assumption of magnetic ballasts, even though most T12 systems have already been retrofit with electro-magnetic ballasts;
- The assumption of standard wattage T12 lamps, even though the majority of T12 systems have been retrofit with energy-saver lamps many years ago.

For a 2-lamp fluorescent system, claimed lifetime savings can thus be exaggerated to be as much as 10 times higher or more than what is actually achieved.

Air-compressor market opportunity incentives offer another example of misguided savings claims. The Ohio TRM, and perhaps many other TRMs nationwide, use a modulating screw compressor with no air storage as the assumed baseline air compressor. Market opportunity by definition is for equipment that is new or replacing broken equipment – it is NOT a retrofit of existing equipment. Currently in Ohio, there is almost no case where an industry would purchase a modulating screw compressor without storage, nor has this been the case for several years. As a result, energy-efficiency savings from market opportunity air compressor projects are exaggerated.

The market opportunity for air compressor and linear fluorescent measures are just two examples of many. The result is that much of a utility's claimed savings could be better categorized as free-riders, or just plain imaginative. This, in turn, creates distortion in the Demand Side Management (DSM) marketplace, as a large percent of ratepayer's fees are not actually accruing benefits.

Case Studies of Poor Efficiency Implementation

Installing Condensing Hot Water Boilers in Non-Condensing Applications

Condensing hot water boilers are capable of achieving efficiencies above 90%, compared to conventional hot water boilers that typically only achieve around 80% efficiency. Therefore, if a building's main source of heat is from a hot water boiler, the space heating energy consumption can be reduced by around 10% from utilizing a condensing boiler. However, for a condensing boiler to achieve above 90% efficiency, it must operate with a feed water temperature below 130°F, which allows for condensation to occur in the boiler flue gases and extra energy to be captured. Unfortunately, most hot water coils in HVAC equipment are designed to use entering water temperatures between 180°F and 160°F and leaving water temperatures between 160°F and 140°F. Therefore, the temperature of water returning to the hot water boiler is typically above 130°F.

To fully take advantage of a hot water condensing boiler, an HVAC designer must think beyond traditional heating system designs that return water above 130°F. For example, larger heat exchangers may need to be specified throughout the building so that colder water can be returned to the boiler. This can be difficult in a new construction project, since the designer needs to explore different equipment options or heat delivery techniques compared to a traditional building. This can be even more difficult in a boiler retrofit scenario where the building's old HVAC equipment already exists and is designed to operate at high supply and return water temperatures.

Between 2009 and 2011 we studied three buildings with new hot water condensing boiler systems. One building was a new construction LEED office building and the other two were existing schools receiving major renovations through the Ohio House Bill 264 mechanism, which allows schools to finance energy efficiency improvement projects without adding to their net indebtedness. Of these three projects, none utilized the new hot water condensing boilers with return water temperatures below 130°F. On all three projects we measured the boiler efficiencies to be around 80% to 85% efficient, rather than the 90% to 95% efficiency the building owners were led to believe they would achieve.

Poorly applied hot water condensing boilers can easily make it through the LEED review process, as the only area where this technology's performance is tested is in the building energy simulation model. In these models, it is unlikely a reviewer would catch a mistake since the modeled boiler efficiency is buried deep into the model and there is no practical way for a reviewer to know the boiler's designed feed water temperature. The only person in the process who can ensure this is done correctly is the modeler themselves, and many modelers might not understand how condensing boilers work. They simply input the rated 90+% efficiency from the product literature.

Poor Sequence of Operations for Demand-Controlled Ventilation

Traditionally, ventilation systems are safely designed to always provide ventilation to an area as if it were at maximum occupancy conditions. However, building zones are rarely at maximum occupancy, making the supplied ventilation air excessive. Excessive ventilation air causes increased heating and cooling energy to condition outside air.

Demand-controlled ventilation (DCV) is a control setup that allows building ventilation systems to automatically vary ventilation to an area based on occupancy. ASHRAE 62.1 standards describe an acceptable methodology for applying DCV to a building using carbon dioxide (CO_2) sensors. If a zone is unoccupied and CO_2 levels approach ambient conditions, the ventilation rates can be reduced to a rate designed for an area with little to no occupants. As occupants enter the space and CO_2 levels increase, the ventilation rate begins to incrementally increase back to the design rate for maximum ventilation.

DCV is very advantageous in areas with intermittent occupancy and large occupancy swings, since this provides the best potential for ventilation reductions. DCV is often installed in areas such as offices, meeting rooms, gymnasiums, presentation halls and cafeterias. Through building energy modeling and energy auditing experiences, we often find DCV to be one of the most effective technologies for reducing heating and cooling costs. Throughout past projects we commonly calculate DCV to have the potential to save total space heating energy consumption by 15%-30% in Ohio regions. In retrofit projects, we typically estimate DCV to have a simple payback of less than four years. This simple payback is much faster in new construction projects.

Unfortunately, we rarely see this technology properly implemented without the strong assistance of an outside commissioning agent. Between 2009 and 2011, our team commissioned five LEED buildings in Ohio and Tennessee with DCV. Of these five, none initially designed and installed the DCV in a way in which energy savings could be achieved. In fact, one of the buildings installed the controls in a way that actually increases energy use. In all projects, the issues were due to insufficient construction document instructions to the contractors. To properly install DCV, a lower ventilation rate for zero occupancy and an upper ventilation rate for maximum occupancy must be specified by the design team along with instructions of how to modulate ventilation between these two limits based on the zone's CO_2 levels. These specifications did not exist for four of the five projects. On these four projects the installer simply did not tie the CO_2 sensors into the ventilation system and ventilation rates were kept constant at the maximum occupancy design rate.

On the project where specifications did exist, the specified logic was incorrectly written so that ventilation could only vary between the maximum occupancy design rate and 100% outside air, based on CO_2 levels. Therefore, ventilation rates would actually rise higher than necessary in these buildings if CO_2 sensors were reading high levels.

In energy efficiency programs, the poor implementation of DCV can easily go unnoticed. On the projects we have worked on, the design teams had no awareness of how the systems were actually being installed. Additionally, most energy modeling software, such as Trane Trace and eQuest, simply provide a DCV button that simulates a best case scenario of reducing ventilation rates. Therefore, energy modelers can unintentionally overestimate the energy savings from installing DCV.

Finally, we suspect the terminology "minimum outside air" is contributing to the confusion. Engineers and installers generically refer to the ASHRAE 62.1 required air flow rates as "minimum outside air", and believe that outside air flow rates cannot be reduced below this "minimum", even with DCV. However, if the system does have DCV, a more accurate and complete description of the guideline is "minimum outside air at maximum occupancy". It could be described as "maximum outside air when not economizing". In this way, the maximum ventilation rate has been interpreted as the minimum ventilation rate by most design firms.

Excessively Designed Ventilation Rates

Minimum ventilation codes are applied to buildings to help ensure safe and comfortable building environments. Building codes ensure that designers do not under ventilate building areas, but typically there are no codes ensuring that designers do not grossly over ventilate areas. As a result, building designers tend to err on providing excess amounts of ventilation air. Furthermore, to save time, many of the engineering design firms we encounter develop conservative rules of thumb for air flow rates per square foot for different building areas. These rules of thumb can be quickly applied without specifically referring to codes or investigating the space's occupancy intent or ventilation delivery system. Through our commissioning and energy auditing of buildings we often back-calculate the building's designed ventilation rates and compare them to the rates that ASHRAE 62.1 standards recommend. In most cases we find ventilation rates to be significantly higher than those recommended by ASHRAE 62.1. Though sufficient ventilation is a necessity for buildings, over-ventilation comes at an energy cost penalty, since it requires more outside air to be heated and cooled to room temperature. By replacing ASHRAE or state mechanical code ventilation calculation guidelines with conservative rules of thumb, many design teams in the Midwest are creating less efficient buildings. In addition to increasing building energy consumption, over designing ventilation rates can lead to increased capital costs due to the larger equipment needed to meet the excessive air flow rates.

Heating and cooling ventilation air is a very significant portion of heating and cooling loads in buildings. In a large hospital we audited, for example, we estimated potential energy savings of over $300,000 per year from reducing ventilation rates in several large areas. It should be noted that the design engineering team was also consulted to help ensure that reducing the existing ventilation rates would still result in a rates that exceeded local code for the area types. These savings are partially so large because the existing system ventilation rates were based off of older standards and the existing systems were designed with energy recovery wheels that were no longer functional.

Excessively Designed Lighting Levels

The Illuminating Engineering Society of North America (IESNA) and other organizations publish suggested lighting levels for different zone types in buildings. Good lighting designs ensure these minimum lighting levels are met through performing photometric models or calculations to determine the minimum number of light fixtures needed to achieve them. Similarly to ventilation rates, we often find lighting designers develop conservative rules of thumb, which tend to provide areas with excessive lighting levels. Thus, even though high efficiency lighting fixtures are specified, the building still has a high lighting wattage per square foot because so many lighting fixtures are installed.

Through enhanced commissioning of LEED buildings we have commonly encountered zones with high lighting power densities and excessive lighting levels. One example of a scenario we encountered was in a building that struggled to meet ASHRAE 90.1 lighting power density guidelines. Through enhanced commissioning review, we discovered several of the main spaces, which were already equipped with abundant natural lighting, were designed to have lighting levels close to 200 foot-candles. The IESNA only recommend about 30 foot-candles for such spaces (IES Handbook, Ninth Edition). Not only did this over-lighting of the area create an energy efficiency penalty for the building, it also significantly increased the building construction costs due to the installation of many unnecessary fixtures.

One avenue for excessive lighting designs to get into buildings is the application of the building area calculation method, as opposed to a space by space method for light power density (LPD). These two calculation methods are acceptable to meet ASHRAE 90.1 standards. In some exceptional circumstances the whole building area method can be necessary. However, it typically is not, and only allows for efficient lighting design in one area of the building to offset an inefficient design in another area.

Meeting ASHRAE 90.1 Lighting Standards With Inefficient Fixtures

As mentioned above, we commonly see zones designed with excessive lighting levels. However, we also commonly see green buildings that meet the ASHRAE 90.1 lighting power density guidelines with inefficient lighting fixture technologies, such as metal halides or incandescent fixtures.

In 2011 we commissioned a LEED New Construction workout facility equipped with 250-W low bay metal halide lighting fixtures all throughout the main workout areas. Technically, these 250-W fixtures were spread out enough that the design exactly met the required 0.9 Watts per square foot, specified by AHRAE 90.1 standards. Unfortunately, these fixtures could have easily been replaced with high efficiency fluorescent equivalents and the lighting design could have far exceeded the baseline standards. Typically, linear fluorescent equivalents cost about the same as metal halides to install and draw about half of the energy to provide a better quality of light.

In our experiences with design teams in the Midwest, HID lighting fixtures are often still the comfortable preference as long as the design still meets ASHRAE 90.1 guidelines. This is often due to old habits and ingrained practices that are difficult for designers to change without investing additional design time to explore newer technologies. One example of how inefficient designs can make their way into LEED can be seen in the main office of a high profile regional design firm located in a LEED Platinum office building. Ironically, the building’s entire entrance lobby is lit with metal halide fixtures, which often remain on at night when the building is unoccupied, and are always on during the day when there is an abundance of daylight.

Throughout the state of Ohio, we have studied at least 15 schools newly constructed to meet ASHRAE 90.1 and other energy efficiency standards with metal halide lighting fixtures in the gymnasiums. Humorously, in most of these projects a local performance contracting firm came through and upgraded the metal halide lighting systems with high-bay fluorescent systems within less than three years.

Improper Utilization of Variable Frequency Drives on Fans and Pumps

Variable frequency drives (VFDs) are commonly installed on pump and fan motors to efficiently modulate the speed of the motors. VFDs are often most cost-effective when applied to motors that experience variable loading throughout the year or on oversized motors that chronically operate under-loaded with heavy pump throttling or fan dampering. However, through commissioning and energy auditing, we often see VFDs installed on pump and fan motors in ways that do not achieve maximum energy savings.

One common problem we find is that facilities purchase and install VFDs on motors with constant loads and are always operated 100% loaded. We have commonly seen this taking place during energy auditing of facilities aggressively trying to reduce energy consumption. As a first initiative, the facility managers talk to vendors and are convinced to install VFDs on all of their large pump and fan motors, regardless of the existing load profiles. We have seen this on dozens of pumps and fans over the past three years in buildings such as hospitals, industries, schools and exhibit spaces, among others. Most building owners and efficiency advocates are aware that VFDs exist and can save energy. However, many do not realize exactly how they save energy and when they should be applied.

Another common issue we find with VFD installations, is when a VFD is being used on the pump or fan motor simultaneously with throttling or dampering. For maximum VFD energy savings, a fluid system should be operated 100% open and only the VFD should be utilized to slow the motor down, as a means to reduce fluid flow. This issue does not just occur in retrofit scenarios, but also in new LEED buildings where new motors with VFDs are balanced and calibrated with usage of throttling valves and dampers, rather than with the VFD. An example of this is a constant volume make-up air unit we observed with a VFD controlled supply fan. The fan was balanced by closing of the damper and the VFD was left to constantly run around 100% full speed. The energy-efficient way this should have been done was to leave the outside air damper 100% open and to balance air flow by slowing of the VFD.

One of the most egregious examples of misused VFDs was in an industrial facility. A 1,500-hp pump motor was equipped with a VFD and run at part speed. However, a valve was throttled 50% closed in the system. For over 2 years, facilities staff had misunderstood plant engineer’s directions for operating the system. Unthrottling the valve saved about $50,000 per year in electricity at no cost.

These poor applications of VFDs can be difficult to catch, since much attention needs to be placed on how the systems are tested and balanced, along with the typical load profiles of the designed systems. This is information rarely given to a building energy modeler, who simply clicks a button on the modeling software to indicate a motor is VFD controlled.

Inappropriate Applications of “Green” Technologies

Design firms commonly specify systems to buildings simply because they are marketed as “green” without evaluating their appropriateness for the project or fully understanding how they operate.

For example, we worked on three LEED projects with one design firm that has specified new variable refrigerant flow (VRF) HVAC systems for three consecutive buildings. These VRF systems have the capability to dramatically reduce energy consumption in buildings with simultaneous heating and cooling loads because the system can extract heat from one zone receiving cooling and relocate it to another zone needing heating. Thus, the heating is free in this scenario. Unfortunately, without accounting for the free heating during simultaneous heating and cooling periods, these VRF systems do not save significant energy savings over normal high-efficiency air-source heat pumps (ASHP), but they cost significantly more. In all three of the projects this design firm specified VRF systems for, there were no significant simultaneous heating and cooling loads. On top of this, the design firm did not design and specify the systems correctly to take advantage of the free heat during simultaneous heating and cooling. Therefore, the building owners simply paid more money for a system that sounds greener, but will not actually perform better than less expensive, standard ASHP systems. The main cause of this issue is that the design firm did not fully understand how VRF systems achieve energy savings. After several meeting with the design firm to discuss the selection of the VRF system, it became clear to our team that the designers only understood that the system was known to be a cutting edge energy efficiency technology. They did not fully understand how it achieved its claimed energy savings and left the majority of the designing tasks to the vendor selling the equipment.

Another example of misapplied “green” technology is a school that installed a state of the art ice storage system to supplement their air conditioning. This system allows the building to generate ice during the night hours when the building is unoccupied then use this generated ice as a cold sink to cool the building during the day. This technology is very appropriate for air conditioning dominated regions of the country where electric demand costs, due to air conditioning, represents a large portion of their energy bills. An ice storage system actually increases a building’s cooling energy consumption, but offsets peak power demand.

The school district staff claimed the ice storage system saves almost as much energy costs as a ground source heat pump, citing the mechanical design engineer. However, this is not true since Ohio is a heating dominated region of the country and the school is currently closed most of the summer due to the academic schedule.

Solutions to the Problems

Overcoming a culture of inefficiency will become easier once parties responsible for design and implementation of efficiency projects are held accountable through third party measurement and verification. This process is beginning to take place in LEED projects, as continuous measurement and verification is likely going to be offered as an option for additional credit in LEED 2012. It is also rumored that standards and requirements for measurement and verification of LEED certified buildings will continue to get tougher over the years and may eventually become mandatory.

Along with measurement and verification must come a better understanding of baselining and benchmarking standards and when each is appropriate. Baseline standards include ASHRAE 90.1 standards, and are a great tool for defining the technologies and design practices that should be minimally expected in a non-energy efficient building. Comparing building designs to a good baseline helps define a starting point from which to define what energy efficient design entails. However, comparing a building system to a theoretical baseline system does not necessarily indicate how a building actually performs with regards to energy efficiency. The only way to do that is to benchmark the building.

Benchmarking is a means of evaluating how a building’s actual energy performance stacks up against itself, before efficiency retrofits, or how it stacks up against other peer buildings. A popular benchmarking metric for commercial buildings is EnergyStar Portfolio

Manager. This program allows for facilities to check their performances relative to a large database of peer buildings from the Commercial Buildings Energy Consumption Survey (CBECS). If a facility is implementing retrofit efficiency changes it may be necessary to benchmark its actual energy consumption against itself prior to the retrofits. We call this a past-performance benchmark, as opposed to Energy Star which is a peer-performance benchmark. This can sometimes be problematic since outside variables, such as weather and building occupancy patterns can impact energy consumption regardless of the efficiency retrofits. Thus, this type of benchmarking often needs to be performed with statistical analysis by an unbiased technical expert.

Both baselines and benchmarks are necessary for the Midwest to evaluate the success of energy efficiency initiatives. Gradually evolving baseline standards help push the design practices in a more progressive direction, while benchmarking standards make it possible to evaluate the effectiveness and impacts of the more progressive changes. The two interact with each other. As both become more embedded into energy efficiency programs, the Midwest will be able to better understand where they are and how to best make improvements. It will also be possible to better hold parties accountable for poor design practices.

Another large change that would significantly reduce poor energy efficiency implementation is for building owners to change their expectations and attitudes towards engineering designers. Typically, projects are expected to move fast and design firms are not paid enough or given enough time to actually think critically about the systems they create. Building owners can add a lot of value to their buildings if they set the tone with design firms that heavy design work and comparative system analysis should take place before any design decision can be made. At this early stage, it is also advantageous to bring in other experts, such as enhanced commissioning agents or a technical owner’s advocate. Though these upfront engineering requests may cost a building owner slightly more in design fees, it should pay back significantly throughout the project. Examples of where this practice pays back should be found not only in energy savings from a more efficient design, but through reduced equipment and construction costs. By forcing design teams to evaluate multiple system types, the owner can actually select systems that achieve the most energy savings per dollar invested, rather than getting stuck with a potentially more expensive system that saves little to no additional energy. Also, the design teams should be forced to take their time and better design lighting, ventilation, ductwork and piping systems, rather than applying excessive rules of thumb. This should result in smaller systems and less equipment and construction costs, in addition to lower energy consumption.

Lastly, technical reference manuals used by state incentives programs to quantify energy efficiency project savings must be continuously reviewed, critiqued and updated to ensure calculation methodologies and baseline assumptions are appropriate as technologies change. An example of why this is necessary is mentioned earlier where modulating screw compressor without storage are assumed to be the baseline scenario in Ohio’s technical reference manual guidelines for retrofitting to efficiency air compressors.

Conclusions

Even though the culture of energy efficiency in the Midwest slightly lags that of the Northeast and West Coasts, the demand for energy efficiency is steadily catching up and the culture will likely catch up as well. The keys to getting to where we need to be will require the efforts of designers, installers, building owners and efficiency program directors. All parties will need to learn how to hold each other accountable and how to break out of their old decision making habits which were developed without energy efficiency in mind. As parties are held more accountable for achieving stated savings, a competitive market will force design teams, building owners and program directors to make better decisions on how to invest in energy efficiency. By making some of these changes, energy efficiency savings will begin to be realized at a faster rate in the Midwest and the bar will continue to be set higher and higher.

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