

Energy Lessons Learned with LEED: One School System's Experience

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ABSTRACT

Montgomery County Public Schools (MCPS) in Maryland has maintained a strong focus on energy conservation for over 30 years, incorporating sustainable design practices for major capital projects and utilization of latest technology energy management systems. The paper discusses how MCPS's in-house design team:

- Establishes clear expectations for outside consultants and A/Es working on new and modernization projects with a LEED Administrator scope of work
- Provides real-world performance feedback to designers and school building users on school annual energy use
- Supports an integrated design process by strengthening staff resources in mechanical engineering and civil engineering as well as providing LEED training as professional development to all staff
- Developed a system of continuous improvement with mandatory LEED post-project reviews
- Regularly updates Facility Design Guidelines so that all capital projects would meet LEED requirements
- Revitalized the HVAC and building commissioning process to meet the performance goals

Introduction

Montgomery County Public Schools, the 16th largest district in the county, has 200 schools, enrollment of 142,000 and over 21 million square feet in facilities. As a growing suburb of Washington, DC, MCPS's Capital Improvements Plan includes two or three new or modernized schools to be opened each year. The school system is required by Montgomery County to have all new schools or modernization projects meet LEED Silver level certification or its equivalent in another rating system. Two schools have received LEED certification to date. Great Seneca Creek ES was the first school in Maryland to receive Gold while Francis Scott Key MS, completed in the fall of 2009, was the fourth middle school in the country to receive Gold. Sixteen additional schools are registered with USGBC and are in various stages of design/construction or are complete, occupied and awaiting certification. All of them are tracking LEED Gold.

Energy conservation is not new to the school district. In addition to tracking energy consumption and continually striving to improve building operations and maintenance, the interest in energy has been reflected in new schools designed and built by the school system. Over the decades, new technologies have been piloted and assorted design strategies employed to reduce Btu/sq/ft and-- more importantly--to support improved student learning.

This paper addresses the recent changes in new construction processes and practices that were spurred by the US Green Building Council's Leadership in Energy & Environmental

Design rating systems, known as LEED. It focuses on lessons learned implementing LEED for Schools projects at MCPS from 2007-2010.

A major conclusion of this paper is that, for this school system, the biggest challenges in “greening” the design of new schools are not technical. The “human factor” of getting individuals to share an environmental goal and work as a team, encouraging consultants to embrace unfamiliar ways of doing things, and the importance of providing feedback on actual performance of the building are all discussed in some detail.

Lesson 1: Owners Need to Make Expectations Crystal Clear

All MCPS contracts with architects contain a requirement that the project—if it is a modernization or new school—must obtain a LEED Silver Certification. Initially this requirement was a performance specification and detailed no practices or procedures. (A/E negotiated contracts may include fees for additional services such as daylight modeling or energy modeling.) However, MCPS has found that it is more beneficial to reference a “LEED Administrator Scope of Work” which was developed to clarify expectations in regard to LEED.

This scope of work requires a LEED Online Administrator, if he/she is an employee of the A/E firm, to not additionally serve as project architect. Experience with the first few LEED registered projects revealed that the majority of the workload required to document and upload LEED credits occurs during the same time frame as major design tasks. While there is always the exceptional individual that can juggle the dual responsibilities, MCPS felt that it was better for the architect to assign another individual or hire an outside LEED consultant.

Value of Interim Energy Modeling

The LEED scope of work also calls for energy modeling at various stages of design—before design development, at mid-construction documents stage and a final LEED energy model. The requirement for early energy modeling upon which design decisions can be based has been met with some skepticism from engineering firms. They needed to understand that the energy model did not have to be completed at three different stages, but rather it was a rolling development throughout the project design. MCPS feels it is crucial to an Integrated Planning Process to be discussing the energy design options early in the process to develop the most efficient design. In one case, an energy modeler was able to use the energy model from another project to generate “what if” scenarios.

Design Guidelines versus Owner’s Project Requirements

MCPS assigns general management and oversight of the LEED process which includes review of the Owner’s Project Requirements (OPR) and the Basis of Design narrative to the LEED Administrator. Regular meetings and updates are required so that progress can be maintained. Commissioning agents regularly review the OPR to track the project. Some architects develop an OPR based on previous projects and simply modify them for the specific project. The OPR is not required to be provided to the LEED review team, but it is supposed to communicate the owner’s expectations and overall performance goals for the project.

Rather than preparing individual OPRs for each school project, the MCPS design team updated the school system’s Facility Design Guidelines to incorporate LEED requirements and

sustainability initiatives from the USGBC, the State of Maryland and local regulators. Facility Design Guidelines pertain to all new construction including addition projects that are not LEED-registered. This was a more systematic approach to establishing MCPS design expectations. Each MCPS subject matter expert (electrical, mechanical, architect, etc.) was asked to draft and/or revise a different section of the Guidelines and the resulting web-based document effectively catalogs all the important school system design goals and parameters for MCPS construction projects. This was a huge undertaking that took many months. In some cases, the existing guidelines (such as those impacting Site) had to be thrown out altogether and new language drafted.

Once the job was completed in early 2009, DOC Director James Song called a meeting of all A/E Design Firms to draw their attention to the revised Design Guidelines and to underscore their importance. At that meeting, the LEED Scope of Work was distributed and important changes to sections of the Facility Design Guidelines were highlighted and explained. In addition to the architects, civil engineering firms were asked to attend, as many of the new requirements pertained to their work.

Once the revised Facility Design Guidelines were published, MCPS provided a letter to commissioning agents, stating the level of certification sought for a given project and informing them that the Guidelines were to serve as the Owner's Project Requirements.

Living Documents

Updates to the Facility Design Guidelines and the LEED Administrator Scope of Work are often incorporated as real world lessons are learned. A case in point is the LEED credit for pre-occupancy Indoor Air Quality management. The credit provides for buildings to be either flushed out or to undertake indoor air quality testing. Prior to MCPS developing a standard way of meeting the requirement, one project, (already behind schedule) tried to perform the flush, but performance issues with the equipment meant that required temperature and humidity levels couldn't be maintained. The team then opted for IAQ testing, but--by the time decision was made--the school year was underway and it was too late, as LEED only permits the air quality testing prior to occupancy.

The result of this experience is MCPS's decision that all projects will be flushed to the minimum requirement of LEED and that the construction schedules on LEED projects will be adjusted so that there is time to either complete the full flush to LEED specifications or to conduct air quality testing, with re-flush of certain areas if required.

A different timing-related issue is that of LEED documentation. While USGBC review teams have been generous in granting time extensions, there is significant variation between when a school completes the process and receives LEED certification. Since these timing extensions cannot be assumed, MCPS has provided submittal timelines for all LEED documentation in scope or work. MCPS opened three schools in Fall of 2009. Only one of them, Francis Scott Key Middle School, completed its LEED documentation and obtained a Gold level certification before the doors opened in August.

Lesson 2: Build your Staff Expertise and Create a Shared Goal of Integrated Design

With a total of sixteen current USGBC-registered school projects in various stages of design and construction, there was concern about wasting project time and resources through developing and re-inventing LEED credit compliance strategies for each and every project. For example, three projects that were attempting to meet the LEED prerequisite for acoustic performance each developed their own unique approach to meeting Sound Transmission Class (STC) requirements for interior classroom walls. Designers and contractors were confused and no one seemed to know how to meet the credit. A more systemic approach was clearly called for.

But first, MCPS needed to cement in-house staff expertise and foster collaboration in order to support the goal of an Integrated Design Process.

LEED Classes for Design Staff

It started with LEED AP training scheduled during work hours. The seven MCPS project managers were encouraged, but not required, to attend and the course was made available to other staff interested. The result was a full class of 20 that participated in a six week course taught by a local sustainable design consultant. The consultant's training as an architect and her significant experience working with other school systems provided real-world validation that the task of meeting LEED was indeed achievable. Inviting participation from staff members from other departments also proved helpful. The Director of School Plant Operations helped develop a system-wide Green Cleaning Plan, which is submitted as an Innovation Point on many projects and won a national award. The Assistant Director of Transportation is leading efforts to upgrade the bus fleet with low-emitting filters, helping us achieve another LEED goal.

Architect James Song, the director of DOC, personally attended most of the LEED training sessions and also offered to reimburse the testing fee for any staff that obtained LEED AP accreditation. As design team staff was added, Song sought out professionals with civil engineering or mechanical engineering background, based on his understanding that energy performance and water/site issues were going to be critical to future school system sustainability efforts. A new position for Mechanical Team Leader was created. This PE coming from the private sector did not automatically adopt the school system's conventional wisdom. A comprehensive scope of work was developed for commissioning agents that includes what LEED terms "enhanced commissioning" for all LEED projects. A LEED program manager was also recruited, with the express charge of informing management about any potential failure of a project to meet the required LEED Silver level certification.

Developing Our Own Scorecard

When MCPS initially started registering LEED projects (2007), most A/E firms hired by the school system had little or no experience designing a LEED project, even if they did have a LEED AP on staff. Moreover, the team was dealing with a new LEED rating system, LEED for Schools.

To help consultants better understand MCPS needs (and as an excellent in-house exercise in understanding our own priorities and biases), the MCPS project managers collectively developed what is termed the MCPS Typical LEED for Schools Scorecard. Each project

manager on the design team represents a different discipline: architecture, mechanical engineering, civil engineering, electrical engineering and structural engineering. When developing the Typical Scorecard, project managers representing the various disciplines had to weigh in on the credits that pertained most to them and decide whether or not the credits were worth pursuing. Project managers as a group puzzled over what the credits meant, how they could be achieved, and at what risk. Everyone emerged with a better sense of what the intent was behind the various credits and an appreciation of how we could get to the desired Silver level.

The result of this collaboration was a scorecard with 36 credits marked as definite “yes” choices, which would only get a project to Certified level. Ten credits were marked “no.” The remaining 33 credits were in the “maybe” column, which makes sense as many credits are necessarily site-specific. The A/E firms were told to pay strict attention to the “no” column as well as those marked “yes.” Rationale emerged as to why MCPS did not want to pursue certain credits. As an example, to meet Indoor Environmental Quality credit 1 (Outdoor Air Delivery Monitoring), there was concern that the school system maintenance staff, already resource-constrained, would not be able to provide calibration for CO2 monitors that would have to be located in every classroom. Other credits in Energy and Atmosphere such as EAc5 Measurement and Verification and EAc2 On-Site Renewable Energy were deemed simply too expensive.

Lesson 3: Track Energy Consumption and Relay it to the User

Montgomery County Public Schools has relied on billing data to track energy consumption in its facilities for over 30 years. A school facilities resource conservation plan is filed every year with the County Department of Environmental Protection. System-wide lighting retrofits, strategic investment in new HVAC technologies and energy management control systems are all part of the overall school system effort to control energy costs.

More recently, monthly electric consumption data for each school has been posted to the web and all schools are required to file a School Energy & Recycling Team (SERT) action plan at the start of the year. The SERT program provides financial incentives for teams of building service staff, students and teachers that are successful in reducing electricity consumption or who are observed practicing good energy conservation behaviors. Evening and unannounced daytime visits by SERT Facilitators provide the data for the behavioral awards.

The MCPS Energy Manager briefs the Construction design team annually, presenting data on the energy performance of recently constructed schools. While the schools are identified by type of HVAC system, in reality it is impossible to make an apples-to-apples comparison even with projects of similar square footage. Schools operate with different community use hours, with different levels of technology and with other major energy variables such as portable classrooms.

It is still notable that the two best performing schools are the LEED Gold level certified Great Seneca Creek Elementary School and its sister school with the same design. Both schools utilize a geo-exchange heat pump system and both underwent commissioning.

Three LEED schools opened in Fall 2009. Energy performance thus far has been promising. After six months, the two elementary schools are each operating at an annual projected level of 37,000 Btus/sf which is comparable to the best energy performance of any of our schools. The middle school, however, is coming in at about 59,000 Btus/sf, which is more than we would like to see. Data on these schools is provided to the architects and mechanical teams, as well as to the Commissioning Agent, before the LEED required follow-up site visit.

A major thrust for the MCPS design team is to sharply reduce the time it takes to get a school's heating and cooling system functioning properly. MCPS's mechanical team leader brought in several new firms to provide commissioning services. Every LEED project will have enhanced commissioning per LEED and MCPS also requires the commissioning agent to review documents at 35%, 65% and 99% review stages. This goes beyond LEED requirements. Controls experts and the MCPS mechanical team are also present at the design reviews and work closely with the mechanical, engineering and plumbing team and commissioning team.

Lesson 4: Listen to Building Occupants

Energy numbers aside, a key indicator of a successful design is occupant satisfaction. The principal of Great Seneca Creek ES was not a green building enthusiast at first. He now proudly tells visitors that his green school has a 100% staff retention rate and that students at his school can tell you exactly how the water cycle relates to their building.

LEED EQ credit 7.2, Thermal Comfort Verification, is of interest to the Division of Construction as a means of getting feedback from all staff at newly opened schools. (The Division of Construction also surveys principals and others on the facility advisory committee regarding their satisfaction with the design and construction process.)

The Occupant Comfort Survey used by MCPS solicits feedback not only on temperature and thermal comfort, but also seeks opinion on visual comfort, indoor air quality and acoustics. The web-based survey is anonymous, but respondents are encouraged to provide contact information if they want the Department of Facilities Management to contact them. An interesting and somewhat complicating requirement of LEED for Schools is that students Grade 6 and above should also be surveyed.

The LEED credit requires that the survey be administered between 6 and 18 months after occupancy. Originally, it had been the plan to administer the survey at the 6 month mark, in order to take advantage of any energy concerns and include them in the Commissioning Agent's review of the building's operation 8-10 months after occupancy. However, with some projects experiencing delay in final commissioning, it seems wiser to wait a longer period before surveying.

The survey for Francis Scott Key MS was administered in May 2010, after 10 months of occupancy, and the results will be available by the time this paper is presented.

All thermal comfort issues in the first two years (whether identified via the LEED survey or resulting from another form of communication) will be screened by the school's Building Service Manager and referred to the MCPS Warranty Compliance Manager, who will then contact equipment manufacturers if appropriate.

If the issue does not involve equipment under warranty, the school's Building Service Manager will contact the appropriate division (Maintenance or Energy Management).

MCPS uses a computerized work order web-based system called MAXIMO, which will carry the date and nature of the complaint and track the actions and time taken to resolve the issue. Major assets carry a unique barcode which are linked to work orders and the software tracks accumulated maintenance costs. This system has the potential to provide input to future HVAC design choices. For example, data from Maximo shows that the geo-exchange system in Matsunaga ES (our oldest such system, installed in 2002) has not incurred any repair costs to date.

If the results of the occupant comfort survey indicate that more than 20% of occupants are dissatisfied with thermal comfort in the building, MCPS Department of Facilities will work directly with the school's building service staff, the school's team, and maintenance and energy management central staff to collect data on actual temperatures and remedy the problems.

Importance of actual data cannot be understated. Students at Sherwood High School a few years ago conducted a School Temperature Survey, in which they collected temperatures from every classroom in the building and also noted whether windows were open and whether ventilating units were obstructed. The resulting data—in some cases, temperatures over 85 degrees F in February—were shocking to the school's administration. The maintenance department correctly noted that no work orders had been recently filed—apparently, school building service had simply decided that there would not be an adequate response. Happily, the temperature data chart had the effect of mobilizing a team and egregious problems were promptly corrected.

Lesson 5: Share What You Learn

While the event is still fresh, it is good to document experiences resulting from the LEED process. At the request of MCPS, the commissioning agent, architect, construction manager (CM) and various MCPS staff involved in design and construction of Francis Scott Key MS came together for a post-LEED process review. During the debrief, MCPS asked for suggestions on how a more integrated design process could have been achieved. There was discussion on getting energy modeling into the process at an earlier stage and whether a specialized energy modeling firm or the project MEP was the appropriate choice. The construction managers talked about their efforts to communicate LEED expectations to subcontractors on the job. The commissioning agent and the CM agreed that a LEED pre-construction meeting would be helpful before the schedule is developed. Responsibility for the flush out requirements of LEED was agreed to rest with the CM. In sum, the post-LEED debrief was found by all participants to be a useful exercise.

Since each design team is essentially self-contained and not communicating with other design teams, MCPS helps all parties by sharing information across projects. A spreadsheet indicating the number of energy points each project was attempting was distributed to project managers, A/Es and LEED administrators. Projects that were targeting a lower level of points were quietly encouraged to set the bar higher.

LEED credit narratives that successfully pass USGBC review are maintained by MCPS and shared with other project teams if the credit seems to be one that triggers a lot of request for clarifications. For example, LEED reviewers consider achievement of the thermal comfort verification credit (the occupant survey) dependent upon first achieving thermal comfort design. The design credit calls for meeting the requirements of ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy. For reasons of energy efficiency, MCPS does not air condition gyms, which are considered by LEED to be a core learning space. There was disagreement amongst engineering consultants as to whether this credit could be met, but one firm researched and selected language from the standard showing that the standard was meant to apply to occupants in sedentary or near-sedentary activities—typical of classrooms, rather than a gym. The DOC now provides that specific language to any project attempting to meet the credit.

Local Green Schools Network Forming

Previously, clarifications regarding what strategies would qualify as acceptable to LEED came from Credit Interpretation Rulings or CIRs. A database of past CIRs could be searched for relevance to a particular issue and cited to document a certain approach. Now, however, USGBC has decided that a given CIR will be specific to only one project. Since the LEED for Schools rating system has some unique credits and requirements, MCPS decided to invite other local school districts to form our own informal network and share LEED experiences. The first such network event is scheduled for Spring 2010 and, from the initial response, will attract facility designers from around the region.

Lesson 6: Seek Opportunities for Renewable Energy and Green Roofs

The LEED for Schools rating system encourages on-site renewable energy and purchase of green power, but it is safe to say LEED has not been the driving force behind school system initiatives in these areas. In the case of green power, county government mandated that all agencies purchase a minimum of 20 percent renewable electricity, starting in 2011. In this process, the county puts out requests for bids and the schools component is just one part—although a major one—of the overall procurement. While this county requirement has helped MCPS meet both the basic green power LEED credit and the exemplary performance credit available, the timing of the procurement does not always coincide with submission of LEED documents.

Government plays a role in MCPS procurement of on-site renewable energy as well (LEED EA credit 2). Federal tax incentives for private firms installing photovoltaics have produced companies eager to partner with institutions willing to “host” the PV systems while purchasing the electricity produced at a competitive rate. These third party purchase power agreements allow the supplier—in our case Sun Edison—to finance, install, own and maintain solar PV systems on school roofs. The systems do not penetrate the roof deck and do not void the 20 year roof warranty. The supplier is able to receive tax credits and sell Renewable Energy Credits (RECs) to Maryland electric providers. There is a strong correlation between production of kWh from the PV system and our school system’s peak electric demand. MCPS currently has 1200 kW of PV installed on eight schools and would like to bring that amount up to 7500 kW by the year 2016. New schools are a particularly good candidate for PV, as SunEdison plans to keep the arrays up for at least 20 years.

Green Roofs Sprouting Up

One reason that goal may be difficult to achieve is that MCPS rooftop real estate is in demand for other reasons due to recent stormwater regulations promulgated by the State of Maryland. A 900 sf vegetated roof was installed as a pilot project at Northwood HS in 2005. Then another small roof (1200 sf) was incorporated into a new elementary school in 2009.

This year MCPS is required to use environmental site design to the maximum extent practicable, making green roofs almost unavoidable on our very limited existing school sites. In two years, by the end of 2011, four more major vegetated roofs will be installed on new schools, providing a total of over 100,000 sf. And, unless stormwater control regulations are changed, by 2014, the school system will have over 400,000 sf of green roof installed. The school system just

published a green roof design guideline, calling for vegetated tray systems that are 95% fully grown in at time of installation. This helps curb need for initial maintenance and provides full stormwater benefits from the start.

Summary: We Are Still Learners

As should be clear from the above, MCPS has not yet arrived at true integrated resource planning, nor has the Division of Construction become expert at complying with LEED.

However, significant progress has been made, both in the easier documentation of the LEED projects and in developing the trust and collaboration needed to continue on the path towards a more integrated design.

Reflecting on the lessons learned, MCPS would suggest that--as owners--investing in staff training/knowledge base and openly sharing LEED experiences is absolutely essential before we could hope to influence our network of A/Es, consultants, contractors and clients. We're now pushing the engineers to bring to our attention new systems that haven't been approved by regulators yet but have the potential to serve multiple-purpose sustainability goals. One example is a technology that employs an underground series of perforated pipes to temporarily retain stormwater but also allow it to move up through the special sandy soil mix to irrigate playing fields above. We've asked the state to change some of its requirements so that traditional comparative analyses of HVAC systems could be replaced with in-depth investigation of cutting edge technologies that we would like to pilot test.

More Than a Scorecard

Thanks to LEED, those of us in the design side of the Division of Construction have a much stronger understanding of what is important to us—not necessarily what gives us a point on a scorecard. For us, maximizing comfort and building energy performance are more important than “bells and whistles” sometimes found on green buildings. We are doing our own study of the benefit /cost of individual LEED for Schools credits and the results of that exercise will change our Typical Scorecard.

Making expectations crystal clear is getting easier as we all get more versed in building green. A glance around a recent project's LEED kick-off meeting showed 12 different consultants and program folks, 11 of which were LEED APs and all of whom had already participated in an MCPS LEED project.

Completing the Circle

Making the connection from the building user's experience back to the design team is a challenge we are just starting. We've learned that some problems with a new building are quietly “fixed” by school staff, without ever making it to a complaint log. Getting all parties to communicate with each other and publicizing the actual energy consumption of all the new schools for the information of the design teams will help us improve our energy performance. We welcome the USGBC initiative to provide real world consumption data on LEED certified buildings.

Just as we start to get comfortable, however, and congratulate ourselves on 16 schools all tracking Gold, we face new uncertainties. The next step for new projects is LEED 2009, a rating

system that clearly benefits the urban project. Our schools are sited in the middle of residential neighborhoods, at a time when most children walked unaccompanied to school. Meeting Silver level under the new rating system will force us to do even more with building envelope design and move onto even more efficient HVAC systems. Water issues will continue to grow in importance and we will be looking to keep—and reuse—every drop of rain that falls on our sites.