Commissioning of Smaller Green Buildings-Expectations vs. Reality

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ABSTRACT

The United States Green Building Council's *Leadership in Energy and Environmental Design* (LEED™) certification process, which establishes design parameters and guides the construction cycle for sustainable or "green" projects, is fast gaining popularity among building owners. Building commissioning, the process of verifying and ensuring that fundamental building elements and systems are designed, installed and calibrated to operate as intended, is a prerequisite for all LEED™ projects and performing enhanced commissioning tasks can be used to obtain an additional LEED™ credit. For projects using the LEED system, there has been much confusion about commissioning's goals, costs, and scope.

The paper reviews the authors' research on the costs, scope, and problems associated with commissioning LEED™ buildings under 60,000 square feet. The authors examine the most common conflicts and their causes. Topics discussed include the perceived and higher costs of commissioning small LEED™ buildings and the role of the commissioning agent in the LEED™ process. The paper also discusses various strategies for commissioning smaller LEED™ projects.

Introduction: Building Commissioning and the LEED™ process

In 1993, the U.S. Green Building Council (USGBC) was organized to advance green and sustainable construction practices in the United States. The USGBC established its *Leadership in Energy and Environmental Design* (LEED™) standard to evaluate and rate "green" buildings. The framework provided by the LEED™ system assists an owner or developer in making the choices that add up to a sustainable structure. A project earns credits by satisfying requirements in five categories: sustainable sites, water efficiency, energy efficiency, materials and resources, and indoor air quality (IAQ). Some credits are required "prerequisites" while others are optional. The total number of credits determines the building's final LEED™ rating: certified, silver, gold or platinum. Commissioning plays an important role in this system by providing a "check" to ensure that measures designed to meet LEED™ goals actually perform once implemented.

Like traditional commissioning, the costs and scope of LEED™ commissioning vary widely. For many of the parties involved with their first LEED™ project,

commissioning as a quality assurance system is new, and some are surprised by what they perceive to be its high costs.

Research for this paper sought to determine the costs of commissioning a small LEED™ project, and to explore which parties are performing the commissioning tasks on these projects. Interviews were conducted with people working on LEED™ projects, and the authors also discuss PECI's experience with LEED™ buildings. The projects studied reveal great variation in commissioning practices and costs. In fact, the authors' original hypothesis, that commissioning costs on small LEED™ buildings would be higher than the norm, was not proven by the research. Projects studied here report commissioning costs at or below those of "traditional" commissioning.

LEED Commissioning Requirements

How do LEED™ commissioning requirements compare to a traditional commissioning process? LEED™ 2.0 guidelines specify six steps necessary to fulfill the building commissioning "prerequisite" requirements. These steps must be completed for all projects, regardless of the rating they are seeking. They require the project to: engage a commissioning agent; develop design intent and the basis of design documentation (required even if the commissioning process is started after design); incorporate clear and complete commissioning requirements ideally in the construction specifications or through explicit change order; develop and use a commissioning plan; verify installation, functional performance, training, and documentation; and complete a commissioning report.

In order to verify that these requirements have been met, the USGBC requires the submission of a signed copy of the commissioning plan (highlighting these six requirements) and a letter signed by the commissioning authority attesting to the successful execution of and design intent and the commissioning plan.

In addition to requiring commissioning as a prerequisite, an additional LEED™ point can be obtained for "additional commissioning." In order to receive the extra credit the project must: conduct a focused design review prior to development of construction documents by a qualified third party other than the design team; conduct a construction document review when close to completion by a qualified party other than the designer; conduct a selective review of contractor submittals of commissioned equipment; develop a recommissioning management manual; have a contract in place for a near-warranty end or post occupancy review.

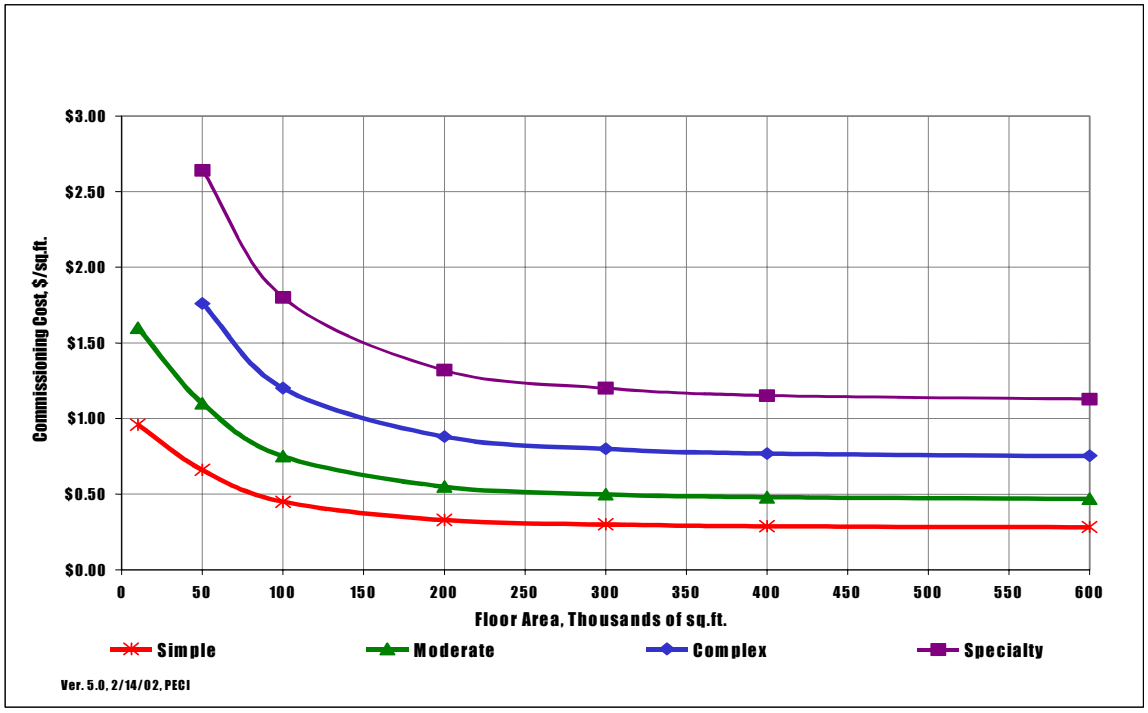
As in prerequisite commissioning, to verify that these requirements have been met the USGBC requires the submission of a signed copy of the commissioning plan (highlighting these five additional tasks) and a letter signed by the commissioning authority attesting to the successful execution of these tasks.

Traditional (Non- LEED™) Commissioning Costs

Since in many respects the commissioning industry is still fairly young, research on commissioning costs is limited. Figure 1 below gives commissioning cost guidelines for traditional design and construction phase commissioning activities. Since these

guidelines are based on a limited number of projects, they should be used with some caution. (PECI, 2000 and Wilkinson, 2000)

Figure 1. Estimates of Construction Phase Commissioning Costs
(Costs for the commissioning authority in new construction, per square foot)



Source: PECI, 2000/2002

Simple = office buildings, classrooms, packaged equipment and controls; common systems, fewer pieces of equipment.

Moderate = more complex office, classroom with some labs, building automation, more control strategies, fewer packaged equipment; more systems (fire, emergency power, etc.).

Complex = Moderate plus most of floor area in complex systems (hospitals, labs, operating rooms, clean rooms, fume hoods or other non-HVAC systems are commissioned such as electrical quality, transformers, security, communications, etc. Traveling requirements and high cost of living locations increase costs.

Specialty = Very complex facilities

On any project, commissioning costs vary considerably with project size and building type, equipment, commissioning scope and the travel requirements of the commissioning provider. In traditional commissioning projects, there is a direct correlation between building size and the *total* cost of commissioning: the larger the building the higher the cost of commissioning it. The cost model in Figure 1 also predicts that smaller buildings will have higher commissioning costs on a *per square foot* basis. The rationale for this is that regardless of the complexity and size of a project, a number of basic commissioning tasks must be performed, including: scoping the process, documenting the design intent/design basis, writing a commissioning plan, attending a minimum number of commissioning team meetings. These tasks are necessary and represent fixed costs, whether the project is 5,000 square feet or 200,000 square feet.

LEED™ Commissioning Costs

Given the fact that small buildings represent a significant percentage of all projects registered for LEED™ certification, the commissioning costs and practices being followed are of particular interest. Of the 371 registered (but not yet certified) projects listed by the USGBC, almost half are less than 60,000 square feet. One-third of all registered projects are 30,000 square feet or less.

Several facts seemed to indicate that a small LEED™ building would be more expensive to commission that a traditional building of the same size. LEED™ buildings often employ innovate or unusual systems that would be more expensive to commission, including renewable energy sources such as solar power or wind power as well as low energy HVAC systems, raised floor ventilation systems, and natural ventilation or evaporative cooling systems. For example, commissioning a raised floor ventilation system takes a careful design review, added construction oversight (to ensure proper installation), and a very comprehensive functional test protocol.

LEED™ requires specific commissioning tasks, and the additional commissioning point requires tasks that are above and beyond the scope of "traditional commissioning." The extra work raises commissioning costs. For example, to receive the additional point, functional testing of heating and cooling equipment must occur during the respective heating and cooling seasons. Developing a Recommissioning Manual (LEED™ item 4) also adds time and costs to the process. The exact cost depends on the number of systems and their complexity, not the square footage of the building. Thus buildings such as those seeking LEED™ certification could be assumed to have more complex systems and thus higher costs.

It was also assumed that for most owners, the LEED™ process would be their first introduction to commissioning and therefore they would be less likely to integrate the process at the outset of the project. In such cases, the commissioning authority and the other contractors must work retroactively to develop required documentation. All parties must also retroactively enhance their scopes of work and costs, to reflect the additional labor it will require to complete these tasks later in the project.

Finally, commissioning costs on LEED™ projects could be higher than the norm because the commissioning provider needs to allow for additional time to coordinate with other members of the LEED™ team. In theory much of the coordination and reporting work required by LEED™ should already be in the commissioning provider's scope of work. However, recent experience reveals much confusion over the role of the commissioning provider versus the LEED™ coordinator. On their first LEED™ buildings, owners and project managers tend to confuse the goals and responsibilities required by the LEED™ process with those of the commissioning process. While the project team may certainly turn to an experienced commissioning provider for assistance with LEED™ point interpretations, they should not assume, as has been the case, that the commissioning agent is responsible for coordinating *all* LEED™ requirements.

While these hypotheses initiated the research on commissioning costs in small LEED™ projects, the findings reveal a very different conclusion: commissioning costs for the small LEED™ projects studied here are not higher than for non-LEED™ projects of similar size. The research brought to light some interesting and useful cost-reduction strategies, as well as some detrimental practices occurring in the industry.

Interviews were conducted with representatives from seventeen LEED™ projects ranging from 3,000 square feet to 60,000 square feet. Owners, project managers, architects, utility representatives and commissioning agents all contributed their opinions and experiences. The authors also reflected on their own experiences as commissioning agents on two LEED™ and many non- LEED™ projects. The information assembled includes building square footage, building function, construction cost, commissioning cost, commissioning scope and process. Of the seventeen buildings studied, eleven buildings (64%) reported their actual or estimated commissioning costs in dollar figures. The others were either unwilling to report costs, or unable to do so for one of several reasons. These include: commissioning was performed by owner's staff or the employees of a related agency or department; commissioning costs were part of a design-build package bid; or the project had not yet progressed to determining commissioning costs.

The projects are a diverse group. They vary by size, location, use, construction cost, and type of owner. Among the buildings studied, the Pacific Northwest region is the most highly represented, with eight buildings. The remaining nine buildings are evenly divided between the Western, Eastern and Midwestern states. Their sizes range from a 3,000 to 61,000 square feet. Construction costs start at $250,000 and extend to $18,000,000.

Building functions include elementary and high schools, university classrooms, offices and laboratories, office and retail space, a restaurant and a nature center with laboratories, exhibition space and classrooms. Building owners also span the full spectrum. They include independent small businesses, national corporations, school districts, universities, government agencies, and non-profit organizations. Finally, these projects are at various stages of completion, from design phase through occupancy.

Table 1 below lists the commissioning costs per square foot as given by the interview subjects on each project. As expected, the laboratory/exhibition space/visitor center building was the most expensive to commission. However, costs for the other classroom, office and restaurant facilities varied greatly, and size does not appear to be a determining factor. In some cases, anecdotal evidence suggests that not all commissioning tasks are included in the cost figures listed below. Respondents reported out their commissioning costs as the line item paid to a third party commissioning agent, and then explained that some commissioning tasks were performed by other team members.

Table 1: Commissioning Costs

Building	Total Sq.Ft. (in thousands)	Cx Cost/ Sq.Ft.
Office, showroom	10-20	$ .32
Elementary School	40-50	$ .37
Office	50-60	$ .58
Gallery, meeting rooms	50-60	$ 1.00
Restaurant	20-30	$ 1.30
Office	30-40	$ 1.35
Restaurant, office	1-10	$ 1.78
Dormitory, classrooms, dining hall	30-40	$ 1.95
Office	10-20	$ 2.00
Municipal facility	10-20	$ 2.25
Visitor center, laboratory, exhibition space	50-60	$ 3.19

Among the projects employing a commissioning professional, there is no consistent approach to obtaining bids or selecting a provider. Some subjects report using a formal RFP process and receiving bids from up to six firms. Others discussed the project with a few select providers and then made their choice. In many cases the architect chose the commissioning provider. Architects report soliciting for bids and also relying on past relationships in choosing the commissioning provider.

The remaining six projects were unable to provide commissioning costs because either commissioning was not performed by a third party commissioning agent and fees for those services alone could not be determined, or were not budgeted at a specific dollar amount. Table 2 below lists the various parties that performed commissioning services in situations where a third-party consultant was not used and costs were not provided.

Table 2: "Other" Commissioning Service Providers

Building	Total Sq.Ft. (in thousands)	Cx Provider
Office	1-10	Partner/architect in owner's firm
Bank	1-10	Owner's engineering staff/project managers
Administration	20-30	Architectural/construction team
State office building	30-40	State Department of Facilities staff
City Hall Annex	30-40	City engineering and maintenance staff
Visitor center/preschool	30-40	Engineer with MEP contractor who was not part of design team

Cost-reduction strategy #1: Owner's Staff as Commissioning Provider

Owners and developers on small LEED™ projects are employing a variety of strategies to meet the requirements for LEED™ commissioning while keeping their costs down. Several owners in this study turned commissioning responsibilities over to their own employees. Owners who commissioned "in house" varied greatly in the size and type of their organizations. They range from city and state governments to a small architecture firm and a large national corporation. These owners, despite their differences, each believed they employed people with the technical expertise to shepherd the project through the commissioning process and produce required documentation.

In the city and state projects, commissioning was performed by engineers already on the government payroll. In one case this included members of the building's operations and maintenance staff as well as engineers employed by the construction contractor. In the other case the tasks will be performed by members of the state's facilities department.

In a design-build project for the offices of a six-person architecture firm, one of the firm's principals will perform the commissioning activities. For the partners, this was a cost-reducing measure. Hiring a commissioning agent was deemed too expensive for the $250,000 project. As one of the partners explained, it did not seem appropriate to hire a third party for a relatively simple 3,000 square foot facility being constructed by and for knowledgeable building professionals.

A national corporation undertaking its first LEED™ project is no stranger to commissioning. The project manager reports the company has been commissioning its new facilities for several years. On large projects they routinely hire a commissioning agent. On smaller projects, the project managers and engineers perform the work themselves. They acknowledge the higher up-front cost of commissioning but have found it to be an effective cost-reduction strategy over the long term. The project manager interviewed in the study attended LEED™ training and relies on a LEED™ consultant when questions arise. For this 4,000 square foot office and retail space the team followed the LEED™ requirements but "scaled them down" according to the building's size and the relative simplicity of the systems installed.

Cost-reduction strategy #2: Architect/Engineer as Commissioning Provider

Several projects employed members of the architecture and engineering firms already contracted on the project to perform the commissioning services. In some cases, a commissioning provider or outside engineer was hired solely to test the systems after installation.

For a 5,500 square foot office and retail space, the architects performed all the commissioning prerequisites and hired an engineering firm to test the systems. Their fee was $3,000, less than 1% of the total project cost. A similar approach was taken by the developers of a nature center and classroom building on a 185 acre land preserve. The architect described this 33,000 square foot building as "aggressively sustainable and efficient." The project is design-build, and contractors who specialize in sustainable systems were brought in on the ground floor. The project manager believes this process will eliminate most problems, but plans to hire an outside engineer to test the systems.

Given the complexity of the building, this subject sees the value of commissioning in providing training to the operations and maintenance staff.

LEED™ Commissioning Pitfalls

While this research uncovered some laudable cost-reduction strategies among owners with experts on staff or other technical resources, and enterprising architecture and engineering firms, other less estimable practices also came to light. In some cases both the commissioning provider and the owner misunderstood the total scope of the LEED™ and underbid and subsequently underpaid for the true commissioning costs. Some owners rejected what they perceived to be high bids, and used a low-cost provider who either underbid the project or followed a very narrow scope. Other providers underbid their first project to obtain a high profile job and/or building experience with LEED™ in the hope of obtaining additional LEED™. work in the future.

Next Steps

For many institutions, the rush to use the LEED™ system makes complete sense in relation to their goal to building sustainable structures that will improve the quality of occupants' space and reduce the building's impact on the environment. However, for all members of a LEED™ team, the first LEED™ project and its accompanying learning curve can at best be a challenge, or at worst a very harsh financial lesson. The fact that commissioning is such an integral part of the LEED™ process makes it crucial that both the commissioning provider and the rest of the LEED™ project team carefully approach, plan, and execute the LEED™ commissioning responsibilities. What follows are specific suggestions for working through some of the more common problems that occur during the LEED™ commissioning process.

Define LEED™ Goals

A successful LEED™ project requires involvement and participation by all members of the project design and construction team. A clear definition of each party's roles and responsibilities at the outset of the project will go a long ways towards insuring a smoother certification process. Define what the LEED™ goals and potential "point options" are for your project as early as possible. Having a clear idea of where you are going makes it easier to determine how to get there. Clearly defining these goals in the context of what you can spend for the project as early as possible will also help you in making some of these decisions. The costs of making the jump from LEED™ certified to the Silver, Gold or Platinum ratings can increase construction and accompanying commissioning costs tremendously. These increased costs will probably be exponentially higher as the square footage of your structure decreases.

Provide Adequate Funding for Commissioning

Clearly allocate funding for commissioning and for LEED™ coordination early on in the project budget. Be sure to include in your budget the added designer and

contractor fees associated with commissioning and other LEED™ requirements, especially the documentation requirements. Consider carrying contingency funds to allow for changing scope requirements due to system changes and other LEED™ issues that can and *probably will* arise.

LEED™ Coordination

Hiring a qualified, designated LEED™ coordinator is certainly a desirable step in ensuring that LEED™ goals are met. However, such position is above and beyond the scope of the LEED™ prerequisite requirements. While a qualified commissioning agent may be a candidate for this function, it should not be assumed that the commissioning provider will coordinate all LEED™ activities simply because he or she has been engaged to commissioning the project. To avoid confusion, decide at the outset of the project, or as early as possible, if a separate LEED™ coordinator will be brought on board. If so, set definite expectations for the coordinator's scope of work. Do not expect the commissioning provider to fully understand LEED™, solve problems not related to LEED™ commissioning and/or fulfill all of the LEED™ submission requirements without prior inclusion of this detail in the contract and compensation agreements.

Define the Commissioning Scope and Soliciting for Commissioning Services

Planning for the commissioning process must be done in a methodical manner, for the benefit of both the owner and the provider. As an owner, make an effort to learn about the different professionals who may be qualified to commission all or part of your project. Carefully evaluate the option of using a third party commissioning agent, and consider the advantages and disadvantages of using a member of the design team or contractor's organization as your commissioning provider. Ideally, designate a commissioning provider as early as possible to facilitate the design intent/design basis tasks and, if seeking the additional commissioning credit, the required design review tasks. The earlier a provider is designated for a project where design review is required, the easier and less expensive it will be to rectify design problems before they are implemented in the field.

In many LEED™ projects there are continuous design refinements in the pursuit of maximum credits. This makes it difficult, if not impossible, for a commissioning provider to accurately budget a job. Carefully define with your LEED™ team what you already know about your project (basic building design, systems, LEED™ points selected and intended rating goal) *and* the issues that yet undefined. Carefully define your expectations for the commissioning provider including, but not limited to, commissioning the mechanical and control systems and other applicable LEED™ features, understanding the interactions between these systems and other LEED™ requirements, submitting LEED™ documentation, and providing LEED™ coordination. Consider holding an informational meeting for perspective commissioning providers to give them more information about the project and allow them to ask questions.

As a provider responding to a request for services, analyze the project and your experience in commissioning similar buildings, both LEED™ and otherwise. In your response, clearly spell out your work expectations for the project including the approach

you will take, commissioning tasks you will perform, your LEED™ coordination tasks (if applicable), the number of meetings you expect to attend, travel requirements, and the expectation that additional work beyond this scope will require additional funds.

Evaluate Responses for Commissioning Services

As an owner, carefully evaluate the responses from the commissioning providers interested in working on your project. Does their proposal clearly answer your questions and is their experiences adequate to address the level of complexity of your building and intended LEED™ goals? How do the different cost estimates break out in terms of time budgeted for various tasks, interfacing with LEED™ requirements, and the amount of fieldwork and anticipated number of meetings? Recognize that because LEED™ is a new process, many commissioning providers may have limited LEED™ experience. Set out your expectations for the contractors and design team with required LEED™ tasks. Think about whether the complexity and size of your project demands an experienced LEED coordinator. Shortlist the better providers and then invite them for personal interviews.

Cost Reduction Strategies Utilizing Other LEED™ Team Members

Many approaches have been taken when it comes to dividing up commissioning tasks on smaller LEED™ projects. In some cases, commissioning tasks can be completed by qualified members of the owner's staff, the design team, and/or the construction team. As an owner, recognize that without an independent third party commissioning provider, you will need to put in place a system to report the commissioning's findings to you, prepare LEED™ submittal documents, and avoid conflicts of interest. If you choose not to hire a third party provider to commission the project, be prepared to hire an outside party to inspect and test the systems. Carefully develop LEED™ specification requirements within the construction documents to identify the responsibilities of your contractors and design teams.

Many facilities groups spend time reviewing the construction documents for new projects or modifications to existing facilities. Many times, these review efforts will include the plans, specifications and shop drawings for the project. This type of review is an important component of any commissioning project. On LEED™ projects, documenting this process can help in gaining the LEED™ enhanced commissioning credit. This does not mean that an independent provider will not need to do some review; some effort in this area is required simply to become familiar with and stay on top of the project. However, it may be possible to develop a coordinated approach to the effort that will allow the independent provider to delegate some of the review responsibility to the owner's staff, to the benefit of all involved.

Make use of existing resources when taking on the LEED™ and applying for certification. Consider using project management resources to accomplish tasks such as creating the construction checklist and performing construction observation. In existing facilities undergoing modification, many of the construction observation requirements can be addressed by enabling the existing operating staff to spend part of their time on the construction site. In addition to providing construction observation with a commissioning focus, the operating staff will learn a great deal about the new systems

they will soon be operating, which will provide significant long-term benefits to the facility.

On many building addition projects, the information collected for the O&M program is very similar to the additional point LEED™ requirements for a Recommissioning Manual. By starting the LEED™ process early in the project and acknowledging the resource represented by the O&M staff, owners can task these employees to assisting the commissioning agent during the functional testing process and perhaps even in developing the requirements of the manual.

For new facilities, consider ramping up and bringing the operating team on board during the design and construction process. This will allow them to provide the benefit of their real world operating insight to the design and construction team as the project develops. It will also allow them to provide construction observation services and participate in the start-up of the systems they will eventually own and operate.

Conclusion

The LEED™ green building certification process is in its infancy but growing up fast. The challenges presented by LEED™ commissioning, including learning the value of commissioning, learning how to scope the commissioning tasks required by LEED™, and realizing what the real costs are for LEED™ certification, represent a steep learning curve. Commissioning can be a very complex process and to be successful it requires all team members to work together in planning, executing and documenting the building process. The project teams studied here are taking creative approaches to adapting the commissioning process to fit the project's needs and the owner's budget. Provided these strategies respect the integrity of a thorough commissioning process, they offer excellent models for commissioning small LEED™ projects.

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