



VALUE OF COMMISSIONING 2018 MARKET SURVEY

ACKNOWLEDGMENTS

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EXECUTIVE SUMMARY

The Building Commissioning Association (BCxA) and Lawrence Berkeley National Laboratory (LBNL) collaborated to produce an update to the study "[Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse-Gas Emissions](#)," last revised by Dr. Evan Mills in 2009. The purpose of the current study is to update the metrics and market characteristics that establish the value of the commissioning (Cx) profession in the building industry. This two-pronged study is composed of separate surveys: a data-based survey produced by LBNL and a market-based survey conducted by BCxA. This narrative summarizes the results from this Market Survey, and references key results from the data survey.

The results of the LBNL and BCxA surveys are intended to provide a scorecard on the value of commissioning based on feedback from providers and the building industry now, 10 years later. Defining "value" does require establishing economic metrics to those who procure commissioning services and to those who provide them. However, value also requires definition of the benefits and importance of the commissioning process, which helps market stakeholders understand and advocate for commissioning services.

Project Purpose/Objective

The purpose of this report, the "Market Survey," is to provide feedback on market influences, drivers for procuring commissioning services, incorporation of established Cx practices, as well as the effectiveness/persistence of Cx as a best practice.

This Market Survey is intended to complement the results of LBNL's building data survey. The data survey provides objective results for Cx project economics and factors that drive owners to procure Cx services. The purpose of this Market Survey is to provide insight to define the factors that drive the value of the Cx process.

Two rounds of surveys were sent to BCxA members and relevant stakeholders in 2017 and 2018. A total of 120 subject matter experts responded to this Market Survey. This background of the respondents, including the type of firm, geographic location, and relative size of the firm are described under Demographics, below.

Key Findings

The value of commissioning is defined through the feedback provided by the Data and Market surveys. Some of the highlights that will be discussed in the study include:

- **Cx Certification.** Over 70 percent of respondents indicated that commissioning certification was important to business success.

New Construction Cx (NCCx):

- **NCCx benefits** include a strong ability to drive the level of completeness in building construction, which results in meeting aggressive schedules, addressing construction issues earlier, better design and construction team coordination, and reducing warranty callbacks.
- The data survey results did not provide strong feedback to quantify measurable energy savings due to NCCx. The value of NCCx process can be defined through non-energy savings benefits, such as improved thermal comfort and indoor air quality, better training for staff and longer equipment service life.

Existing Building Cx (EBCx):

- **EBCx** demonstrates its value through energy savings and simple payback. The data survey resulted in **median energy savings** results of 6 percent.
- **Utility-backed EBCx projects** produced **energy savings** in the range of 3 to 10 years, with a **simple payback** of 1 to 5 years, and a median of 2.2 years.
- **EBCx** projects are capable of producing additional energy savings, between 10 and 25% was demonstrated, with additional scope.
- This Market Survey results confirm that EBCx projects with a simple payback of 2 years or less are most likely to be implemented by owners.
- The top issues discovered during EBCx are related to controls sequence modifications. The top 5 sequence-related issues accounted for 95% of the reported measures in the Data Survey.
- The top non-energy benefits associated with EBCx include improving system performance, improved thermal comfort and indoor air quality.

Ongoing Cx (OCx):

- The **OCx** process resulted in **energy savings** across a range of 5 to 20 percent, with a weighted average of 8 percent.
- **Simple payback** of OCx projects were similar to those reported for EBCx projects, in the 1- to 5-year range, with a median of 1.5 years.
- A definition of OCx was not included in the survey, which may have led to confusion over manual vs. monitoring-based commissioning, or continuous vs. periodic post-occupancy commissioning (which is typically embedded in O&M).
- One purpose of OCx projects is to maintain persistence of building performance by embedding monitoring and fault detection and diagnostics (FDD) technology into building automation systems (BAS). The market is still working to drive persistence; however, Market Survey results indicate that only 10% of OCx projects were renewed past the first annual term of installation, i.e., past one-year warranty date.

Drivers and Trends

This Market Survey investigated factors that drove the procurement of commissioning services. Some of the major themes included:

NCCx:

- **NCCx Market Influence.** The data suggests that owner awareness and building codes are increasingly influencing the NCCx market, while Rating Programs may be losing some relevance.
- NCCx services are being selected using at least some **qualifications-based selection (QBS)** procedures for approximately 43 percent of respondents.

EBCx:

- **EBCx. Energy savings is still the number one driver** for implementing EBCx services. Other strong drivers include system performance, thermal comfort and indoor air quality.
- **Secondary EBCx drivers** include LEED™ rating system requirements, utility incentives, extended equipment life, and improved occupancy productivity.

OCx:

- **OCx services are slowly expanding** in the marketplace. The majority of respondents indicated that they have offered OCx services for less than 5 years. Nearly 75 percent of the firms reported performing the OCx process on fewer than two buildings in the previous year.
- OCx is intended as a long-term **resilience tool** for building performance and energy savings. It is interesting that more than 50% of the projects are not renewed past the initial 12-month term.
- **OCx processes** have not yet become part of the core O&M process in operating facilities. OCx is intended to provide operation and maintenance information to help make running a facility easier. *There is an opportunity for OCx providers and OCx vendors to educate owners on this value proposition.*

Scope and Constraints

Questions in this Market Survey regarding the scope of work for New Construction Commissioning (NCCx) indicated that:

NCCx:

- **NCCx design Cx services** are included in more than 60 percent of RFPs.
- **NCCx design review comments** are incorporated into construction documents nearly half of the time.
- **NCCx design phase issues** constitute approximately 25 percent of all NCCx issues.

EBCx:

- The survey confirms that **upfront repairs** are common in the EBCx process. Repairs occur at least “Sometimes” in 87% of the projects.
- Measurement of air and water flow rates through **test and balance procedures** is a common component of the EBCx scope of work. TAB is applied at least “Sometimes” in over 75% of EBCx projects.
- When TAB is applied to an EBCx scope, it is evenly split between performing TAB at the AHU level or at the terminal unit level.
- Despite energy savings being a strong driver for EBCx services, **utility submetering** was not a significant requirement for projects, according to respondents.

OCx:

- A survey question asked if OCx is being utilized as a tool during NCCx or as a standalone tool for existing buildings. The results are mixed, but they imply that OCx is being used more often as a process for existing buildings.
- The use of **fault detection and diagnostics (FDD)** is limited in current OCx services. Over 60% of the responses included the FDD scope “Rarely” or “Never.”
- The most common recurrence for reviewing OCx process results is quarterly, with survey results showing review at least quarterly to be nearly 75 percent. Frequent review of results is considered a best practice for conducting the OCx process.¹

Opportunities

The concern about the commoditization of commissioning costs will continue to be debated, especially as the commissioning industry matures and the demands of the construction industry evolve.

One of the purposes of this study was to maintain consistency with the data collected from the 2004 and 2009 LBNL studies, and to reset the baseline for future studies. This was important in order to maintain consistency in the data to show trends over the past 15 years.

The results of this Market Study have helped to determine which questions should be carried forward into future surveys.

- Continue to gather data on the economics of all forms of commissioning. Commissioning costs are heavily influenced by the number, size and type of buildings surveyed. More data will improve the results, especially for building types outside of the common ones (office and schools).
- The study starts to establish a baseline of the effect of qualifications-based selection (QBS) process, and that information should continue to be trended over time.
- Market influences due to factors beyond owner awareness.

¹https://betterbuildingsinitiative.energy.gov/sites/default/files/attachments/EIS_costs_benefits_report.pdf, page 25

- The cost/benefits of EBCx projects managed through utility programs versus those are not influenced by utility incentives.
- The evolution of the OCx process, including market drivers and scope evolution.

One of the goals of the Market Survey was to provide feedback to commissioning providers on process and scope that can be delivered more efficiently. Issues related to early involvement of Cx services, improved communication with Cx stakeholders, and persistent influence after construction completion are discussed within this study and should be included in best practices development.

DEMOGRAPHICS

The vast majority of respondents for this Market Survey, in all commissioning specialties – New Construction (NCCx), Existing Building (EBCx), and ongoing (OCx), were commissioning providers, shown in Figure 1.

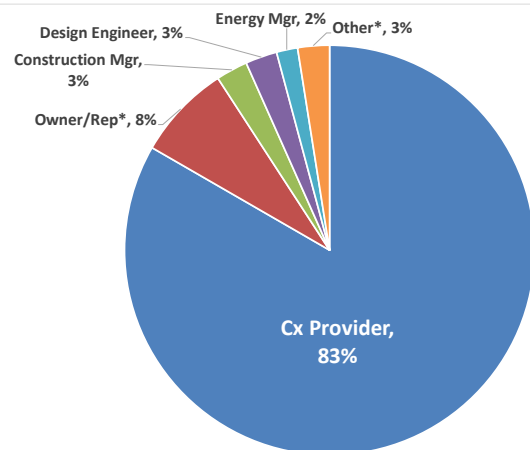


Figure 1. Type of companies represented

The “Owner/Representative” category comprises those who self-described as owners, representatives, facility managers and non-utility program managers. The “Other” category represents those who stated their role as such or were mechanical contractors. Although given the choice, no respondents identified as architects or controls contractors.

Services. Eighty-three percent (83%) of respondents represented that their role is to provide primarily

commissioning. Of that majority, thirty-one percent (31%) represented firms that provided only commissioning services. The balance of those commissioning providers worked for variations of engineering and “consulting” firms. The remaining seventeen percent (17%) comprised contractors, government, university, utilities, and building owners.

Commissioning Teams. Many firms that provide commissioning services appear to execute the work with small numbers of employees. Almost 30 percent of respondents were one- or two-person firms, or employ commissioning teams of two people or fewer. Nearly two-thirds of respondents worked for companies with commissioning teams of less than 10 people.

Locations. Although the separate **building project data survey** conducted by the BCxA/LBNL partnership was mainly focused in three geographic areas (California, Chicago and British Columbia), the locations of firms responding to this Market Survey were evenly distributed across the United States. Also, about 15 percent of respondents were located or provided commissioning services outside the U.S. in Canada, eastern Asia, the Middle East, Europe and Australia.

Areas of Specialty: Practice Longevity

All respondents were asked if, and for how long, they had been providing commissioning services within each area of specialty. Figure 2 below summarizes the results of different types of Cx.

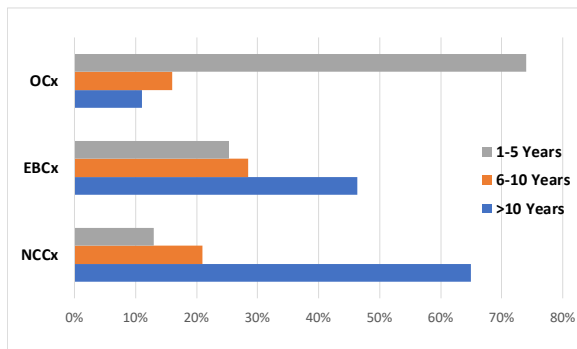


Figure 2. How long have you offered Cx services?

It is assumed that where an answer to the longevity question was omitted, the respondent did not practice within that specialty. Thus, it was determined that:

- 87 percent provided NCCx services
- 79 percent provided EBCx services

According to post-survey commissioning providers who reviewed the results, and because of some industry confusion around the term “ongoing commissioning,” it is possible that ongoing commissioning was assumed by some respondents to represent the warranty period, rather than continuous commissioning for the life of the facility.

Further discussion and evaluation of trends, phases, contributions and issues for each specialty appear in their respective sections.

THE COMMISSIONING MARKET: 2008-09 COMPARED TO 2017-18

From 2004-2008, when data for the Evan Mills studies were collected, the energy efficiency market was enjoying exponential growth. About 80 percent of venture capital investments in 2008 were in the sectors of clean energy and energy efficiency (SOURCE: *Pew Charitable Trusts, 2009*). Forty-six states were offering financial and tax incentives for implementing energy efficiency systems and equipment. Nineteen states, along with utilities across the nation, had established energy efficiency standards for energy generation, transmission and use. Virtually all jobs in the commercial building sector, including commissioning, were thriving at an exceptional pace. Financing for measuring the success of practices and programs was available and utilities, as well as government entities, were offering significant financial incentives for commissioning commercial new construction.

By 2017, when the U.S. building industry had pretty well climbed out of the recession that began a decade before, numerous market disruptions had taken place in the fields of building design, construction and operations. During the intervening period, when new construction was at a relative lull, existing building renovation and commissioning gained precedence over new buildings. New technologies, advances in design tools, materials and equipment, along with commissioning, measurement & verification practices, data collection/analysis, standards and legislation, have all changed the landscape of the building industry.

Certification for commissioning professionals did not exist at the time of the 2009 Study. In an effort to

provide an even playing field for technical specialists in the building industry, the U.S. Department of Energy directed the National Institute of Building Sciences to analyze and develop consistent criteria for workforce in five areas, including commissioning. The Building Commissioning Association's affiliate, Building Commissioning Certification Board (BCCB), was first to achieve and deliver the ANSI-accredited, U.S. Better Buildings-recognized certification exam, the "Certified Commissioning Professional," or CCP. ASHRAE, NEBB and ACG followed thereafter. Company-wide certification now also is available from BCCB to firms that seek the Certified Commissioning Firm (CCF) designation.

COMMISSIONING CERTIFICATION

This Market Survey included questions specifically aimed at the perceived benefits of commissioning certification. Are companies applying for certification, and at what level? Do the companies that invest in commissioning certification find it valuable to the success of their business?

Almost 70 percent of respondents indicated that their firm holds a company certification, regardless of whether individuals also have been certified. This implies that obtaining firm certifications is considered important as a differentiator when firms are marketing or proposing against competition.

Similarly, **almost 70 percent indicated that certification is "Important" or "Very Important" to business success.** This seems to endorse the idea that firms that have pursued Commissioning certifications perceive value in the investment.

The questions did not clarify the perceived value of individual versus company certification, which may warrant further study.

However, when asked, "What percentage of commissioning staff in your firm hold individual commissioning certifications? Figure 3 shows that nearly half of the firms reported broad employee participation (orange) with certifications maintained by more than 50 percent of company staff.

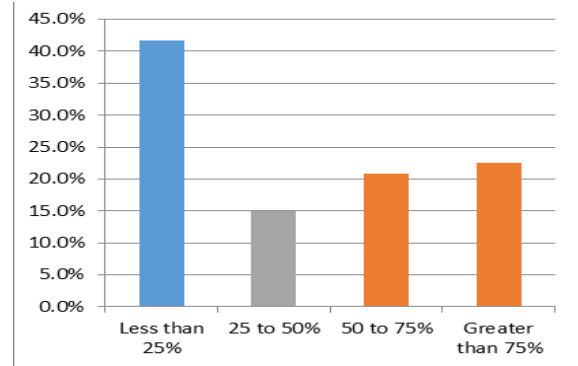


Figure 3. Percentage of Cx staff w/individual certification?

NEW CONSTRUCTION COMMISSIONING (NCCx)

NCCx Market Factors

The survey addressed factors influencing the commissioning marketplace, NCCx commissioning services, strategies and process, building systems and equipment, project phase issues, teaming and communication, and the impact of new technologies.

Factors influencing the Commissioning Marketplace

We asked respondents to rate the importance of each of the following factors influencing the NCCx marketplace. Their overall rating, on a scale of 1-4 (highest), resulted in Owner Awareness and Building Codes having the highest market impact.

Factor	Impact
Owner Awareness	3.8
Building Codes	3.7
Voluntary Rating Programs	3.6
Public Policies	3.5
Utility Programs	3.1
Trade Associations	2.8

When breaking down the blended responses above by category (Figure 4) from “not important” to “very important,” Voluntary Rating Programs such as LEED and Green Globes may be less influential than in the past as legislation and benchmarking for better building performance become more prevalent.

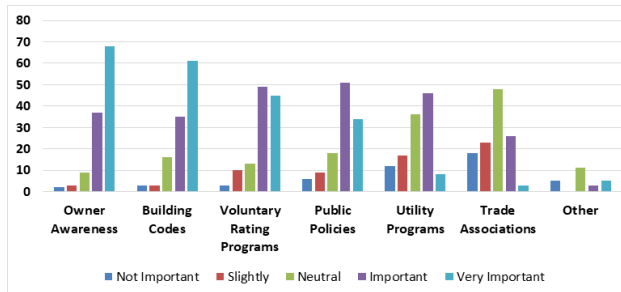


Figure 4. Rate importance of factors influencing NCCx market?

Commissioning Provider Selection Process. As proponents of the qualifications-based selection process (QBS) legislated by Congress for professional services, we asked respondents what percent of their projects were proposed based on QBS versus price-based selection.

The responses to this question were mixed. Nearly one-third of respondents said that less than 20 percent of their proposals were evaluated using QBS. However, 55 out of 119 who answered this question did fall into categories indicating that 40-80 percent of their proposals were evaluated using QBS. As a result, the weighted average of all answers implies that approximately 43 percent of respondents’ projects were selected through a qualifications (first)-based process. Anecdotal evidence indicates this may be an overstatement of the actual use of QBS. Further study that provides a clear baseline definition of QBS would be useful.

Profitability and Market Growth. About half of respondents indicated that their profits are remaining about the same as usual, while 35 percent agreed – or strongly agreed – their services are increasingly profitable. All but 4 percent believed their company will commission more square footage than in 2017 over the next five years, and that new construction and existing building commissioning will both grow, with greater growth in the existing building market.

Who holds the Cx Contract? According to respondents, the majority of commissioning projects involve a contractual relationship with the owner rather than the design or construction team. From the BCxA’s perspective this is good news, as it indicates third-party commissioning delivers recognized value. Respondents said that owners support the commissioning provider during at least 60 percent of the commissioning process. There is opportunity for improvement, however, as demonstrated by the numbers in Figure 5 based on the question, “What percent of your commissioning services are contracted directly with each of the following:”

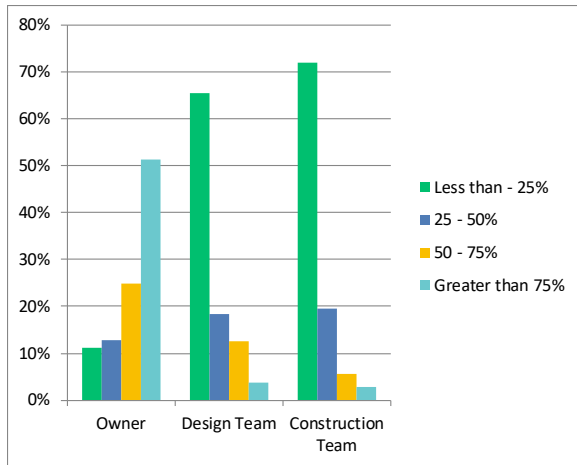


Figure 5. Percentage of Cx services contracted to which party?

NCCx Trends: Survey Observations

Based on Market Survey results, the NCCx outlook remains positive, with the following summarized results:

- Owners are still the strongest driver for procuring NCCx services, and building codes are becoming more influential.
- Commissioning certification has value to the marketplace for over 70 percent of respondents.
- Commissioning is being selected using QBS procedures for approximately 43 percent of respondents.
- Seventy-eight percent of commissioning firms expect to commission more square footage in the upcoming year.
- Forty-eight percent of firms believe that their profit levels will stay the same, while thirty-five percent believe the profits will increase. Only seventeen percent predict that profits will decrease year over year.

At the same time that Building Codes including commissioning become more prevalent, the commissioning community has been successful in some states and municipalities in expanding the scope to include more comprehensive commissioning services.

NCCx Process and Scope

Scope Complexity and Depth

Survey results indicate that the tasks that make up a NCCx scope of work are either staying the same or increasing.

Respondents were asked if the complexity of tasks in their NCCx scope had increased, decreased or stayed the same in the past year. Although a small number indicated their scope had decreased, a full 43 percent replied that their scope had become more complex, per Figure 6.

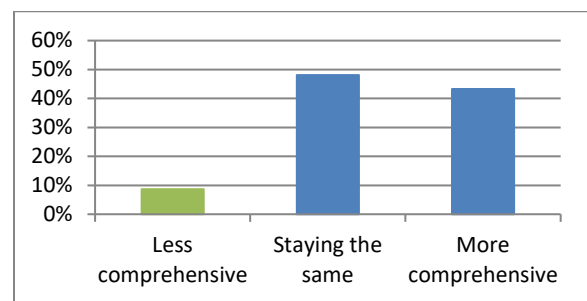


Figure 6. Are NCCx scopes becoming more/less comprehensive?

In response to a question about tasks perceived as “comprehensive” vs. “commissioning lite” (e.g., utilizing BCxA Best Practice recommendations vs. conducting minimal testing and documentation just to “check the box”), most believed their assigned tasks were comprehensive. Only six percent indicated their work included tasks that were less comprehensive than BCxA Best Practice recommendations eighty percent (80%) of the time or more. Refer to <https://www.bcxa.org/knowledge-center/best-practices/> for definition.

This begs the questions of quality and qualifications-based selection, communication, and owner/ stakeholder satisfaction. As Building Code commissioning becomes more prevalent, it is possible that NCCx scopes could be restricted, but for now, the **commissioning scope has exceeded best practice levels more than 60 percent of the time.**

Sampling. A traditional approach to reducing NCCx costs is to allow sampling of redundant equipment, usually at the terminal unit level. The survey indicates that sampling strategies are still commonly in use. The weighted average of responses shows that sampling strategies are a generally accepted

practice acknowledged, if not specifically authorized, in **more than half** of all solicited proposals.

Even though sampling can provide a measure of assurance that systems function properly, it also can be a liability and ideally would be defined in terms of acceptable volume and pricing within contract documents. It is likely that monitoring and verification software for fault detection and diagnostics (FDD) will be increasingly utilized and the use of sampling will be a trend to watch in future studies.

Testing of Building Systems (Beyond HVAC)

To determine whether the complexity of NCCx scopes is changing, we asked how often the NCCx scope of work included systems beyond mechanical/HVAC controls systems, and what was the frequency (percentage) that each specific system was requested in an NCCx RFQ/RFP scope.

As shown in Figure 7, **lighting control was included in respondents' NCCx scope of work consistently, about 75 percent of the time.** Electrical systems commissioning beyond generator testing was applied in approximately 25 percent of NCCx scopes.

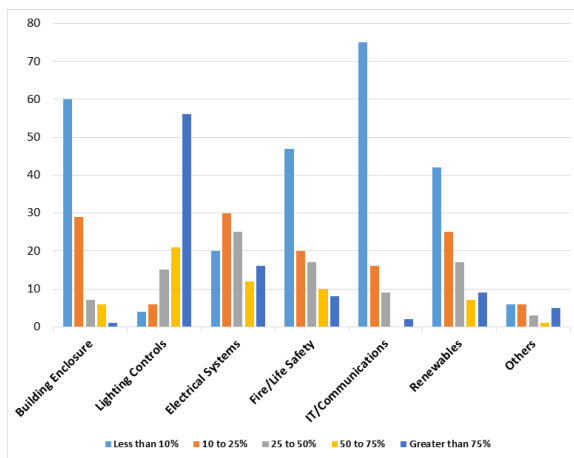


Figure 7. How often were systems other than HVAC included in NCCx scope of work?

For more insight on strategic plans for lighting controls systems, readers may wish to refer to <https://www.prnewswire.com/news-releases/world-lighting-controls-market-forecast-to-2025-300797356.html> for more information.

On closer examination, where systems commissioning is specified beyond the standard HVAC systems, Figure 8 summarizes other systems that are included.

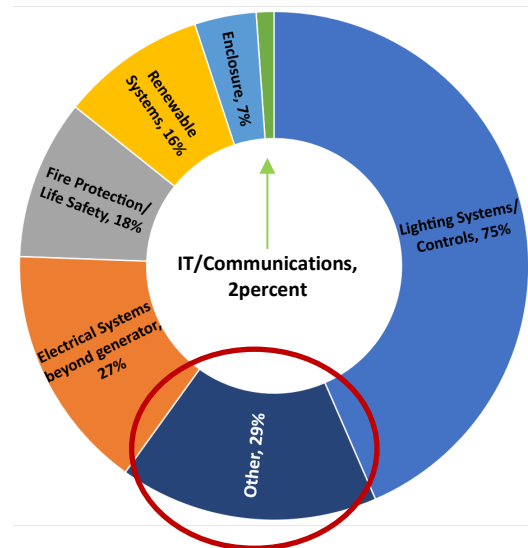


Figure 8. Type of systems other than HVAC included in NCCx scope

The “other” category represents nearly one-third (29 percent) of the total. These “other” systems, shown in Figure 8, may be less frequent, but are either specialized, relatively new as commissioning scope items, or specific to a building type. Possible systems may include:

- Plumbing, onsite wastewater treatment
- Integration testing
- Irrigation & domestic water
- Security systems
- Process hot and cold water, rainwater harvesting, or other water treatment
- Vertical transportation
- Solar PV
- Structural
- EMIS to monitor and provide performance feedback
- Specialty hospital systems, i.e., nurse call, A/V, med gas, etc.
- Regulated systems for manufacturing

Design Phase Scope Narratives

Design phase commissioning tasks such as developing the Owner’s Project Requirements (OPR), conducting design submittal reviews and creating commissioning plans have historically shown high

value to overall building results.² In an attempt to quantify how often design phase commissioning tasks are included in the NCCx scope of work, we asked questions about the inclusion and effects of commissioning during projects' design phase.

When asked what percentage of NCCx projects included design-phase commissioning, the survey shows diverse responses across the board. Here's what we found: about one-quarter of respondents conducted design phase commissioning more than 80 percent of the time — a significant proportion. When combined with the next level, more than half of respondents commission from design onward throughout the project 60 percent or more of the time.

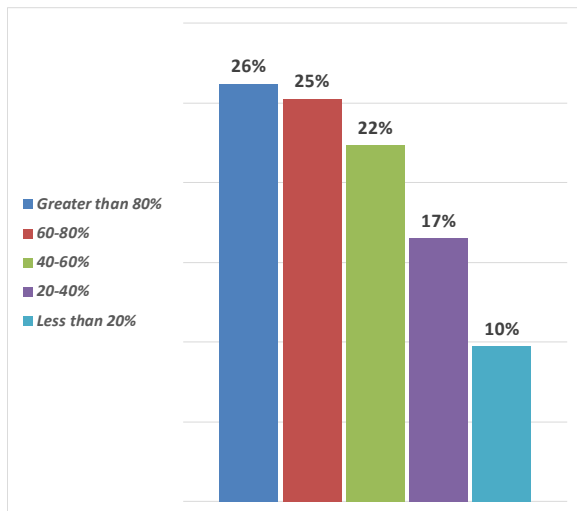


Figure 9. What percentage of NCCx projects included design phase Cx services?

Owners Project Requirements (OPR)

Commissioning providers' responsibilities include working with owners, either pre- or during design, to prepare a formal list of requirements that include the goals, budget, systems, performance criteria and other important aspects of the project; the OPR and the design team's Basis of Design (BOD) are then trued up, with design and commissioning comments accounted for, before construction documents are finalized.

When asked a series of questions about the OPR and the design team's incorporation of commissioning

² <https://www.woodharbinger.com/bca-from-the-field-design-review-process/>

comments into the BOD, respondents answered that their efforts ranged mostly across four "Rarely-Never" combined categories. In other words, as shown in Figure 10, 45 percent of commissioning providers "Rarely" or "Never" prepare the OPR, the OPR is similarly unused or updated throughout the project, the BOD is "Rarely" or "Never" correlated with the OPR, and only half of providers found that their comments were included in the final design.

Scenario	Percent or Frequency	CxP prepares OPR	OPR applied throughout project	BOD correlated with OPR	Design comments include CxP input
1	80-100% - Always	15%	13%	5%	7%
2	60-80% - Often	22%	20%	13%	24%
3	40-60% - Sometimes	17%	21%	22%	19%
4	20-40% - Rarely	14%	24%	53%	26%
5	< 20% - Never	31%	21%	10%	24%
	Rarely / Never Total	45%	45%	63%	50%

Figure 10. Percent of projects including OPR/BOD Cx tasks

Conversely, only 15 percent of providers "Always" prepare an OPR, 13 percent of OPRs produced are applied throughout the project, 5 percent are correlated with the BOD, and 7 percent include commissioning input.

Over 61 percent of responses indicate little or no coordination of the OPR document with the design team's BOD document. Responses point to, and are weighted toward, exclusion (or at least lack of inclusion) and proper use of the OPR and design phase commissioning expertise.

A major cost- and discord-saving opportunity exists for commissioning providers to emphasize (sell) the purpose of the OPR in a way that is not considered contentious by the design and/or construction teams, and shows owners the value of this holistic perspective on the process.

Influence on Contract Documents

When asked what percentage of commissioning review comments actually changed the contract documents before going to bid for construction (assuming a design/bid/build scenario), **respondents indicated that their review comments were carried into contract documents approximately half (46 percent) of the time.** Given the benefit of addressing

issues early in the design process, there is room for improving the effectiveness of NCCx design reviews.

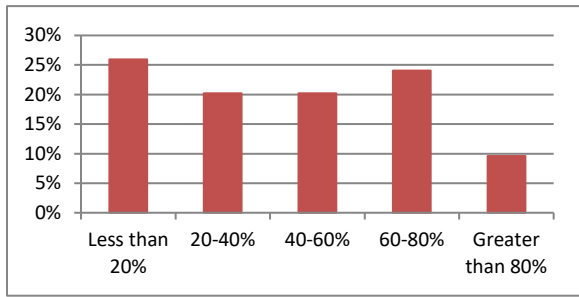


Figure 11. Percent of Cx design review comments actually change the Contract Documents before bid

Contribution to Design Documents

Building Information Modeling (BIM).

Advanced construction techniques now commonly use building information models (BIM) as a core tool for clash detection, pre-fabrication, and construction planning. The survey attempted to determine if commissioning providers are reviewing the electronic BIM model. Based on the responses, commissioning providers' access to, and review of, the BIM model is relatively rare, with most respondents saying they are included in BIM review less than ten percent of the time, and only two percent indicating they can conduct BIM review more than 75 percent of the time. It's possible that BIM and other, newer data-centric and visioning technologies have not yet reached the purview of commissioning providers, and that design/construction professionals are not aware of the value commissioning can bring to their process using these tools.

Energy Analysis. When asked whether energy analysis was performed on the project during the design phase, only one percent said "never." At the same time, only 9 percent answered "Always," with the weighted average indicating energy analysis is involved in 50 percent of projects with an NCCx scope of work. It is not clear from the question or responses who conducted the energy analysis, and often that analysis is done by a party other than the commissioning provider. An earlier survey by the Building Commissioning Association (2016) indicated that energy modeling and analysis were among the three most important *training and education* topics for commissioning providers, but respondents to this Market Survey indicated that energy savings is not as strong an influence on NCCx projects compared to EBCx. There is an increasing desire among some

providers, as well as utility program and facility portfolio managers to include energy analysis in the commissioning scope of work. Based on the results from LBNL's building data survey, the commissioning provider has a limited role in proving energy savings as part of NCCx projects.

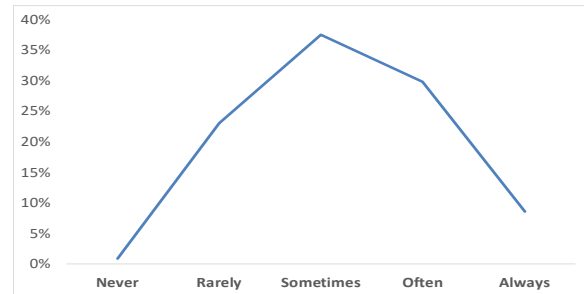


Figure 12. Was energy analysis performed as part of the project? (could be separate consultant)

Control Sequences. We asked for feedback on the level of commissioning involvement in developing strong control sequences during the design process. The survey indicated that projects have minimal coordination during design. Respondents said that control sequences were created by the design team, without significant assistance from commissioning providers, about two-thirds (67 percent) of the time.

According to accepted best practice, to create a good functional test procedure the commissioning provider must thoroughly review HVAC control sequences. Controls coordination meetings during submittals are often a valuable task in the commissioning scope of work. A similar question for the construction phase provides additional insight that controls sequence review is executed during the controls submittal and controls coordination meetings.

In reviewing respondents' evaluation of the *most valuable contribution of commissioning to the owner*, it's clear that commissioning controls, reviewing sequences of operation, and integrating controls with building MEP systems for proper operation are at the top of their list.

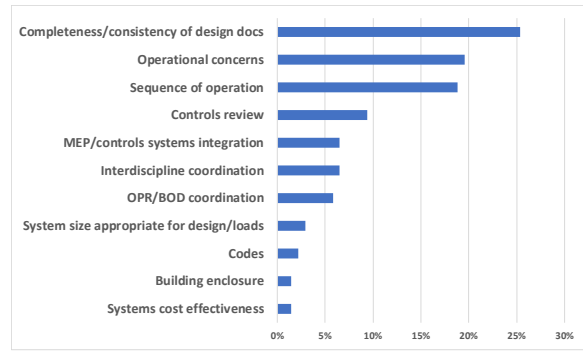


Figure 13. Most valuable Cx contribution to owner

“The development of prescriptive, detailed sequences as part of the design documents is now more critical than ever. As newer, more complex systems are applied to achieve greater energy efficiency, there is a need for equally new and complex sequences of operation...detailed sequences are necessary for the commissioning [provider] to develop proper functional testing. Without detailed prescriptive sequences, the commissioning [provider] must referee various interpretations of a sequence of operation. Altogether, the responsibility for developing the sequences rests with the [provider] and it is critical to be well documented early in the building process.”³ In fact, if not effectively pursued during the design phase, necessary sequences will need to be changed during acceptance phase, which costs more and potentially delays project schedule.

Design Phase Issues Log. One of the ongoing and final commissioning deliverables in a new construction project is an Issues Log. We asked what percentage of issues in the log were identified during the design phase.

This Market Survey indicates **that approximately 25% of the total project issues are discovered during the design phase.** Given the high value and low cost for addressing project issues early during design, the design phase review still appears to represent high value to the owner.

³ <https://www.csemag.com/articles/how-to-write-control-sequences/>

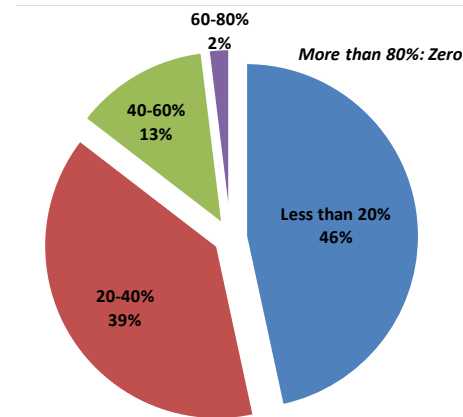


Figure 14. Percentage of All NCCx issues are discovered during Design Phase?

At the other end of the spectrum, only 15 percent said that half or more of their issues were discovered during the design phase, with no one (zero) claiming greater than 80 percent of issues discovered during design.

What does this mean? Does it mean that the design team is right and the construction team is wrong? Does it mean the CxP didn't know enough to catch design flaws? Could BIM or AR/VR have detected these issues? What kind of issues were they, predominantly? Does it mean that things went awry for unknowable reasons?

One can see that education of the value of the design review is needed. With 25% of issues identifiable in design and those review comments only responded to in 50% of cases, there are many avoidable design related issues which commissioning can work to identify for resolution prior to construction.

Construction Phase

Cx Schedule Integration

We asked how often a detailed commissioning schedule is integrated with the construction schedule. The results are evenly split across a bell curve; commissioning schedule integration occurs about half the time. One of the strengths of commissioning is that the process can improve construction execution and can drive timely

completion of the project with minimized change orders.

The construction schedule is one of the most important tools used by general contractors to communicate upcoming tasks with project team members. The typical construction schedule only contains a few line items for controls, test and balance and commissioning tasks, but there are a number of tasks to be conducted by commissioning providers occur throughout construction, with a significant number of steps required to bring the project to full completion.

The commissioning provider must communicate with general and subcontractors to ensure that vital meetings, inspections, and testing occur within the framework of the construction schedule.

Equipment Startups. In an attempt to define the effectiveness and coordination of equipment start-up activities, we asked how often equipment startups are well-coordinated ahead of time. The responses show that start-ups were well-coordinated only about a quarter of the time (24 percent), defined by “Often-Always,” and were “Sometimes” well-coordinated slightly more than half the time.

Proper equipment start-up usually requires advance planning and good communication among the trade partners. Poor coordination often results in schedule delays, additional costs to the contractor due to multiple trips, and equipment damage.

A BCxA-recognized best practice is to review start-up and quality control testing reports and to witness the start-up of critical equipment. The commissioning provider often attempts to coordinate equipment start-up activities through commissioning meetings, but the execution of start-up activities is the responsibility of the contractor.

Cx Influence on Equipment Selection

How often are commissioning comments on equipment submittals incorporated into final equipment selections? Respondents indicated that commissioning comments were incorporated in a majority of opportunities, similar to commissioning comments incorporated during design.

Equipment Review. About 80 percent of responses indicated that commissioning comments are incorporated into final equipment selection at least “Sometimes,” although only 40 percent report their comments being incorporated “Often” and “Always.”

[For reference: Construction Document Review. Slightly more (85 percent) indicated that commissioning design review comments were incorporated into construction documents at least “Sometimes”, while 46 percent reported comments being incorporated “Often” and “Always”.]

The similarities suggest that the effectiveness of commissioning firms’ communication with design teams is consistent between the design and construction phases, and also that there are opportunities to improve the effectiveness of the commenting process. Here are some possible reasons for the apparent lack of effectiveness:

- Format of how comments are documented
- Lack of adequate time in the design phase schedules
- Lack of communication between the design team and commissioning providers
- Lack of adequate design team budget
- Misconstrued context of comments
- Unintended interpretation by the design team
- Design teams do not see value in Cx comments
- Lack of owner support for the review process

Further analysis is needed to understand the reasons for commissioning comments being unrecognized or omitted, and potentially to develop a systematic, “due diligence” type approach to the review process.

Teaming and Communication

Communication among all members of the project team is of utmost importance in managing the scope, schedule, budget and quality of the resulting facility. This Market Survey suggests that there is opportunity to improve communication for completing timely design and construction commissioning tasks.

Meetings. Over 60 percent of respondents indicated they meet with general project teams about commissioning at the right frequency during the project. Another 30 percent felt that meetings were less frequent than they would like.

More specifically with regard to meetings with the owner’s facility personnel during the design phase, the response was slightly less than average with responses ranging from “Never” (7 percent) to “Always” (6 percent).

The survey also asked how important construction teams consider commissioning meetings to be. The firsthand and predictable perception of respondents

was that these meetings were not of great importance to the construction team overall:

Not Important	15 percent
Slightly Important	35 percent
Neutral	23 percent
Important	25 percent
Very Important	2 percent

Of considerable concern, controls coordination meetings with the design engineer, controls contractor and commissioning provider ranged across a similar bell curve. However, in aggregate, respondents consider MEP/controls systems integration, controls review and sequences of operation to represent the most important systems-focused value that commissioning brings to the project.

When only 35 percent of respondents indicated that controls coordination meetings occur “Very Often-Always,” and 65 percent answered “Sometimes-Never,” it begs questions such as who is responsible for establishing and conducting controls meetings, who is responsible for the outcome of those meetings, and who is at risk with respect to ultimate operability and systems integration on behalf of the owner’s investment. An owner’s representative or facility manager would be a useful addition to this group, especially if the commissioning provider is not authorized to modify the controls contractor’s product/process based on the OPR.

Turnover (Occupancy) Phase

The purpose of this phase is to verify the completion of outstanding Cx issues; complete seasonal and deferred functional testing and O&M staff training and occupant orientation; complete systems and commissioning documentation; and ensure an adequate maintenance program is in place. Best practices also include surveying occupants to assess their level of satisfaction.

Issues Remaining at Turnover. The survey asked, what percentage of issues on the Issues Log remain after the Certificate of Occupancy is issued? (A building cannot legally be occupied until the Authority Having Jurisdiction has issued this Certificate.) The vast majority, 87 percent, responded that 20 percent or less of issues remained, with nearly one-third indicating that less than five percent of issues remained on the Issues Log.

On the other hand, in response to the question, how often do commissioning issues remain open and unresolved after *Beneficial Occupancy* (the building can be occupied and, typically, punch list items do remain to be completed.) More than 48 percent responded “Often-Always.” No one answered “Never.”

Operations Training. BCxA Essential Attributes and best practices include verifying that the training for the owner’s operating staff is conducted in accordance with project documents. Commissioning providers typically review the training content and plan and occasionally conduct or participate in training sessions.

In response to the question, how satisfied are you with the quality of the end-of-project training for facility personnel? Responses indicated that satisfaction with the effectiveness of end-of-project training (from the respondent’s perspective) is low. Only 27 percent claimed to be “satisfied” or “very satisfied” with the quality of training, while 35 percent claimed to be “unsatisfied” or “very unsatisfied.”



Figure 15. How satisfied with the quality of turnover phase training to facility personnel?

Proper training of facility personnel should include the following six items at minimum:

1. Conduct system and equipment overview including a walk-through
2. Describe and demonstrate system operations
3. Discuss content and layout of O&M manual
4. Point out safety issues, alarms and common troubleshooting
5. Cover service, maintenance, and preventive maintenance of system components and devices
6. Provide recommendations for maintaining peak efficiency

Commissioning Operations Manuals. How often are commissioning comments of O&M manuals incorporated into the final documents? Just over 66

percent of respondents found that commissioning comments were incorporated into O&M manuals, from “Sometimes” to “Always.” As a primary concern for protecting the assets and investment over the life of the facility, respondents identified operations as the second most-valuable commissioning contribution to owners, immediately following completion and consistency of design documents. Still, the remaining 34 percent indicated that comments were “Rarely” or “Never” incorporated.

Occupant Survey. Do you, or does the owner, conduct a post-turnover occupant survey of satisfaction? A mere 15 percent of respondents answered “Often-Always” to this question, with 85 percent indicating “Sometimes,” “Rarely” or “Never.” LEED allows points for the completion of an Occupant comfort survey.

The survey can be used to obtain feedback from building occupants about thermal comfort, acoustics, indoor air quality, lighting levels, building cleanliness, or other issues. The question may provide insight as to how plugged in the commissioning provider is to building performance during the warranty phase.

Although an occupant survey is considered a commissioning best practice to confirm that a satisfactory indoor environment has been achieved for occupants, and/or identify areas that may need improvement, the survey also can open the door to concerns or complaints that owners do not want to encounter after completion.

Ongoing Commissioning. This aspect of lifecycle performance was not often addressed by respondents, and in fact is not well-understood as a beneficial practice. When asked how often ongoing commissioning tasks are included after construction warranty is complete, well over 80 percent of respondents indicated sometimes to never, with the predominant answer being “rarely.” A definition of OCx was not included in the survey, which may have led to confusion over manual vs. monitoring-based commissioning, or continuous vs. periodic post-occupancy commissioning (which is typically embedded in O&M).

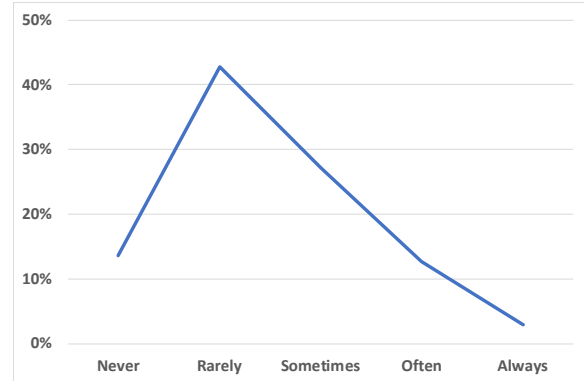


Figure 16. How often are OCx tasks included after construction warranty is complete?

This paper sheds light on the status of Ongoing Commissioning as a discrete commissioning function.

Market Observations and Conclusions – NCCx

Here is a summary of market observations obtained from the NCCx survey results:

- Design phase commissioning services are included in approximately 60 percent of NCCx projects.
- Design phase commissioning review comments are incorporated in contract documents over 50 percent of the time.
- Design phase issues constitute approximately 25 percent of all NCCx issues.

There is opportunity to improve the incorporation of the following NCCx scope items:

- OPR/design intent documents
- Cx involvement in controls sequence development
- Execution of controls coordination meetings during the early construction (submittal) phase
- Improvement of scheduling commissioning related activities, especially in the facilitation of equipment startup and prefunctional checklist activities.
- Collaboration with facility personnel with NCCx activities during design and construction phases.
- Followup with building occupants during warranty/turnover phases.

NCCx Value Proposition

The BCxA Market Study did not ask specific questions regarding energy savings and ROI for NCCx services, but focused on market influences and the effectiveness of specific NCCx scope of work items. The LBNL Data Study did ask for energy savings information, but the responses produced little feedback compared to NCCx cost values. By default, the focus of the value proposition for NCCx services will be on non-energy related benefits. Further study on NCCx economic metrics is merited, especially as:

- Energy savings has a strong influence on the procurement of EBCx services, but is not high on the list for NCCx services.
- The influence of OCx in the marketplace will drive the capture of more energy savings as a de facto measurement and verification process.

Reasons that Owners Procure NCCx Services

The LBNL building data survey reported the top reasons that owners desire NCCx in their projects. Reasons reported over 50% of the time included:

- 79% Ensure system performance
- 65% Comply with LEED or sustainability rating systems
- 55% Smoother turnover
- 53% Ensure thermal comfort
- 50% Train building operators

In the LBNL Study, factors such as building energy savings, improved indoor air quality and occupant productivity were not as high on the list of reasons driving owners to procure NCCx services. It is noteworthy that very few respondents to that data survey tracked energy savings for NCCx projects. Building performance metrics has lost some emphasis by commissioning providers in the decade between the 2009 and the 2018 LBNL studies.

Non-Energy Benefits from NCCx

Since NCCx energy savings and simple payback information was not available from the data survey, benefits from NCCx were obtained for non-energy savings reasons. Data survey results reported the following factors that had immediate benefits to building owners:

- 90%. Drives project schedule, issues are identified and corrected earlier
- 79%. Building is occupied on schedule
- 77%. Improvements to system design
- 74%. Improve construction team coordination
- 56%. Fewer warranty calls and change orders

According to a Dodge Data and Analytics report⁴, construction schedule delays and team communication are among some of the major issues in the construction industry. The benefits listed above should be touted by the Cx industry as strong value propositions.

Ongoing improvements due to NCCx reported by owners after construction is completed included:

- 95%. Thermal comfort
- 87%. Improved operation & maintenance practices
- 87%. Improved training of staff
- 72%. Indoor air quality
- 69%. Improved equipment life

Factors such as increased occupant productivity, equipment performance and indoor air quality result in favorable economics for building owners, and can be claimed as value propositions for NCCx.

⁴<https://www.construction.com/toolkit/reports/managing-uncertainty-expectations-building-design-construction>

EXISTING BUILDING COMMISSIONING (EBCx)

EBCx Market Factors

BCxA members and third-party commissioning providers provided feedback on their experience with the strength of the commissioning market and the technical delivery of commissioning services for existing building commissioning.

EBCx Market Engagement

Existing Building Commissioning is well established after several decades of inclusion in rating systems, building performance improvement, and proven energy and cost savings across the commercial market. Nearly half of all respondents indicated they have offered EBCx services for more than ten years, with nearly 75 percent offering EBCx for more than six years (Figure 2).

Respondents noted that they had contracted for, or performed, EBCx within the past 12 months. The majority of companies performed a smaller number of existing buildings, with just over half commissioning fewer than 5 buildings within the past 12 months. Nearly 14 percent indicated they conducted EBCx on more than 20 buildings over the period.

Building Conditions and EBCx Drivers

Building Age. One question for determining the age of existing buildings being commissioned addressed control systems. Pneumatic controls were commonly used in facilities through the 1980s. Although direct digital controls (DDC) have been primarily specified over the past 30 years, pneumatics were still used to drive damper actuators and control valves. When asked how often the buildings undergoing EBCx contain pneumatic controls (vs. DDC), respondents indicated that pneumatic controls are analyzed as

shown in Figure 17. Pneumatic controls are discovered “Rarely” or “Never” 40 percent of the time.

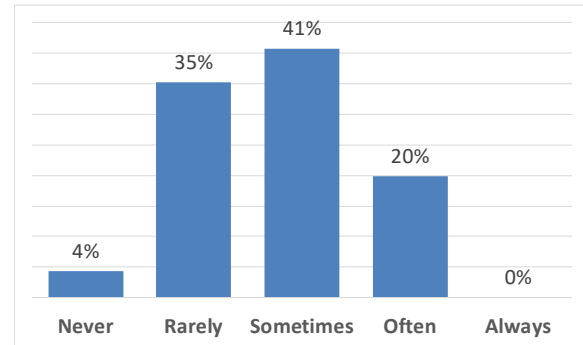


Figure 17. How often do EBCx buildings contain pneumatic controls?

EBCx Drivers

About 61 percent of existing buildings were either “Rarely” or “Never” commissioned prior to the respondents’ projects. Although building age and condition were not revealed for these projects, it may be assumed that the drivers for commissioning were significant enough to bear the cost. Indeed, high-energy cost was the fractionally highest reason for EBCx according to Market Survey respondents, but maintenance and operating issues, and tenant comfort problems were nearly equal to energy cost. The associated building data survey corroborates that system operation and building thermal comfort are factors in over 80 percent of the survey responses. Other, somewhat less important, drivers included LEED rating system requirements, utility incentives, extended equipment life, and improved occupancy productivity. Figure 18 demonstrates the range of reasons for EBCx provided by respondents to both this Market Survey and the building data survey.

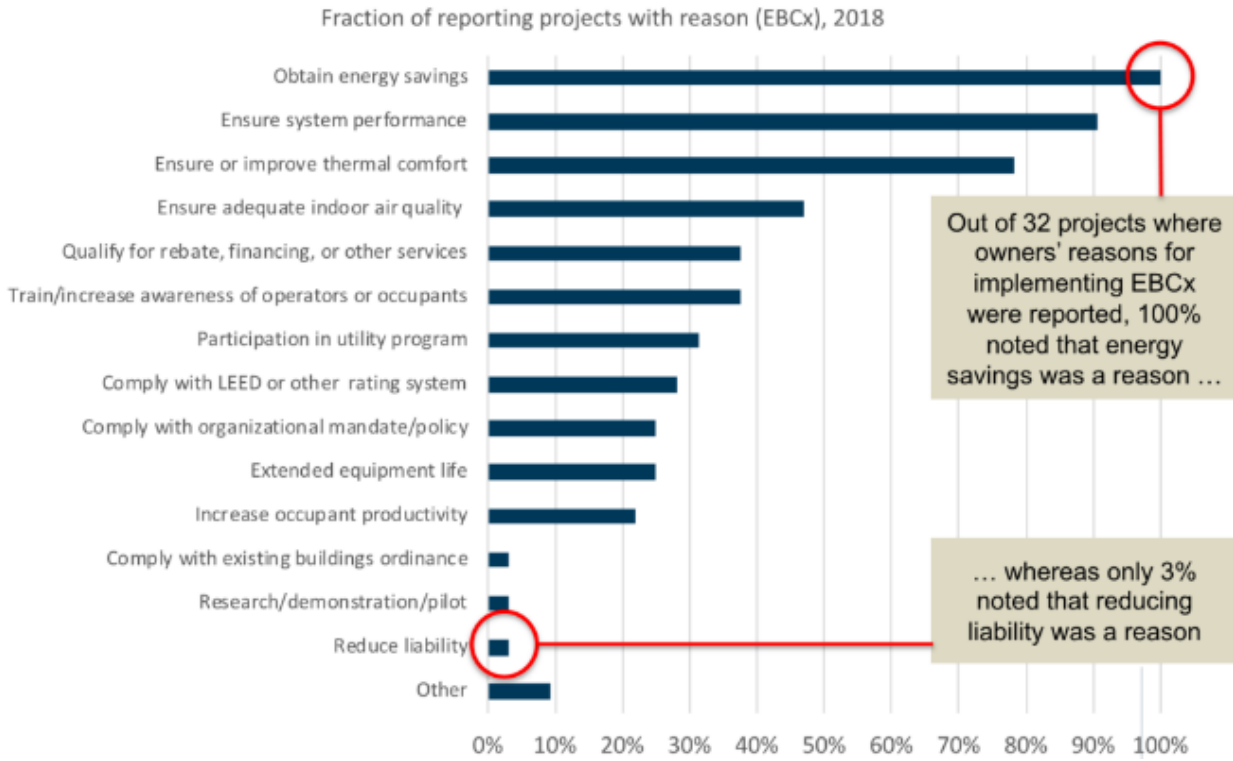


Figure 18. Reasons for implementing EBCx

EBCx Process and Scope

Typical Systems in EBCx Scope

Despite the number of projects completed, the services were not correlated with the building types or commissioning scope. However, when asked how often project scopes included commissioning beyond MEP, lighting systems and associated controls were the most-sought services, followed by plumbing and then electrical systems beyond a generator.

Interestingly, commissioning renewables came in just after electrical systems, fire protection/life safety, building envelope and IT/communication were not commonly included by the respondents, perhaps because these testing and verification services are generally conducted by specialists in a commissioning subconsultant role. In an EBCx scenario, as opposed to new construction, building envelope and IT/communication issues may be more related to fixing failure than tuning-up systems. Also, these specialty services are subject to codes and standards that are separate from other building systems and assemblies.

Facility Personnel Familiarity with Building Systems/Training

Improved building operator training, while less a *driver* than a scope item in conducting the commissioning process, was also indicated as an important issue associated with EBCx. When asked how familiar facility personnel were with building and control systems operations, 87 percent were at least “somewhat familiar” with their facilities, with the majority of those being “moderately” to “very” familiar. The 13 percent who were not familiar with facilities operation were likely in management or executive roles related to their buildings. Since EBCx tends to address system operation at a deeper level, there is a considerable opportunity to use EBCx as a process to include facilities personnel and improve interactive training.

EBCx in an Energy Management Program

Figure 19 from this Market Survey shows that about two-thirds of owners are incorporating EBCx into an active energy management program such as benchmarking, master planning of energy projects, annual reviews and similar activities at least some of the time. Since state and local policies and

regulation are increasingly requiring owners to pursue specific energy use reduction and measurement initiatives (often with resulting penalties for missing the goal), building or portfolio energy management programs, whether voluntary or mandated, can be expected continue to grow.

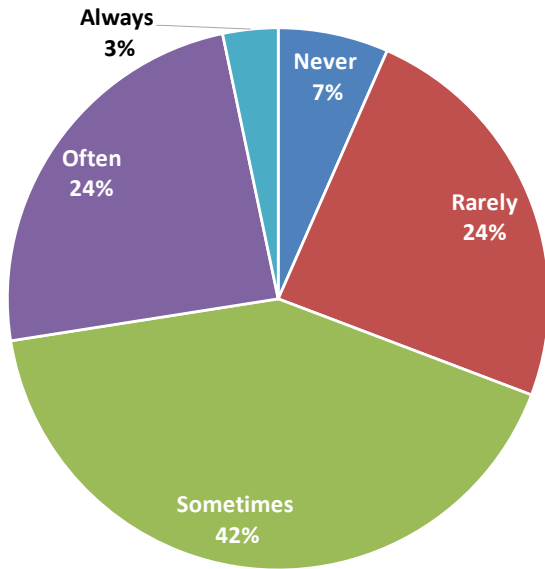


Figure 19. How often are owners who procure EBCx services already engaged in active energy management program?

Energy Audits

Energy Audits. EBCx often results from an energy audit, which may or may not be conducted to justify the decision to commission the existing building. We wanted to know how often an energy audit is performed prior to beginning EBCx projects? It is assumed that an energy audit for establishing the value of EBCx for energy efficiency would include a review of all energy conservation measures (ECMs). Figure 20 shows that responses are weighted toward energy audits taking place prior, for the purpose of identifying ECMs for EBCx, from “Never” to “Sometimes.”

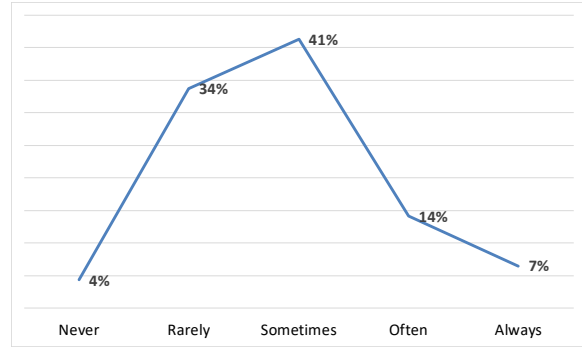


Figure 20. How often is an energy audit performed before the EBCx scope?

Energy Calculations. Energy savings is a top influencer for performing EBCx services. Economic analysis is a key step in the process in order to provide a building owner with economic justification to implement EBCx solutions. The majority of respondents indicated that they perform cost and energy savings calculations prior to the implementation phase between 61 percent (“Often-Always”) and 84 percent (“Sometimes”) of the time.

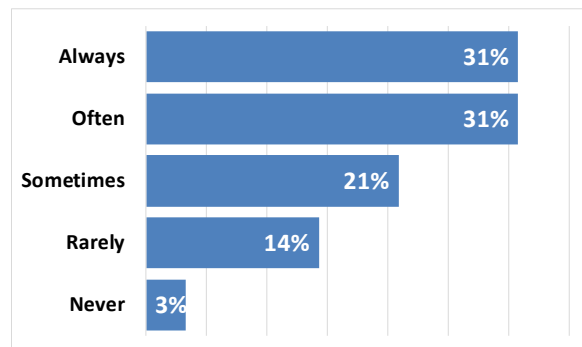


Figure 21. Are energy/cost savings calculations performed in EBCx, prior to implementation?

Repairs required before Investigation. Often, operational and maintenance issues need to be addressed prior to project implementation in order for functional testing to be effective. To understand more about what was (and was not) included in the EBCx scope, we asked how often *significant* work was required to repair HVAC/controls systems before functional testing could begin? These are issues such as controls connectivity, controls software upgrades, and hardware repair. The survey confirms that upfront repairs are common in the EBCx process.

The responses summarized in Figure 22 are indicators that functional testing and systems analysis could not occur in most cases without some

prior correction of existing systems, before the EBCx implementation phase. Repairs occur at least “Sometimes” in 87 percent of the projects, and occur “Often-Always” more than 45 percent of the time.

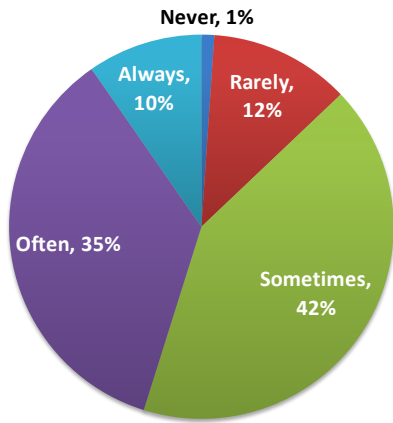


Figure 22. How often is significant repair work required before functional testing could occur?

Using BAS Data Trending for Diagnostics. According to respondents, facilities personnel are not using building automation system (BAS) data trending consistently as a tool. About 13 percent of respondents stated that facilities personnel on their projects regularly use trend logging or BAS dashboards to diagnose building issues. The remaining 87 percent indicated “Sometimes,” “Rarely,” or – for 12 percent – “Never.” An opportunity exists for commissioning providers to either conduct, or train facilities personnel to conduct, improved diagnostics for identifying and optimizing building performance, with or without advanced monitoring systems. Facilities personnel often do use the BAS to review alarms and to review instantaneous values, but diagnostics can be more robust and predictive than that.

Investigation: TAB and M&V

We explored the role of TAB and M&V in the EBCx process. The following section provides feedback on the depth of how TAB and metering was applied to identify building issues.

Test and Balance (TAB) Involvement. Measurement of air and water flow rates through test and balance procedures is a common component of the EBCx scope of work. When asked how often TAB was

included in their scope, respondents indicated that TAB is applied in their projects, at least “Sometimes,” in over 75 percent of EBCx projects, and is applied “Often-Always” in 36 percent of the surveyed projects.

There is, however, a trade-off between the depth of TAB services included in an EBCx scope of work, and the cost to perform those services. The survey results indicate that 45 percent of EBCx project that include TAB services applied the TAB scope of work at the AHU level. Slightly more than half (53 percent) of the EBCx projects included TAB measurements down to the terminal unit level. A mere 2 percent of projects reviewed only the central plant flow characteristics. When TAB is applied to an EBCx scope, it is evenly split when TAB is performed at the AHU level and when it is applied to the terminal unit level.

Monitoring and Metering. How often was utility submetering required as part of the EBCx scope of work? Despite energy savings being a strong driver for EBCx services, utility submetering was not a strong requirement for respondents; only 12 percent included submetering as part of EBCx.

When comparing the use of utility submetering to the using monitoring and verification (M&V) in EBCx, submetering may not play as strong a role in the M&V process, which could be executed using the BAS points or existing whole building meters.

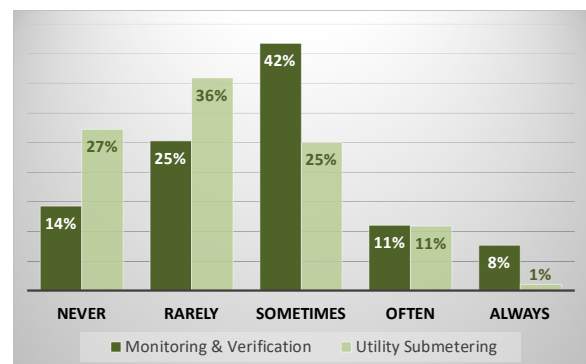


Figure 23. Use of M&V process and Submetering in EBCx process

Incorporating M&V procedures implies the desire to confirm actual energy savings after implementation is complete. According to the survey results, M&V procedures are consistently applied during 19 percent of the projects. The majority of EBCx projects (42 percent) include M&V procedures on a “Sometimes” basis, whereas nearly 40 percent of

EBCx projects do not include M&V as a significant element in the scope of work (“Rarely” or “Never”).

Implementation

Controls. According to respondents, the issues most often discovered during EBCx investigation are related to controls sequence modifications. The top 5 issues shown below accounted for 95 percent of the reported measures in the Building Data Survey.

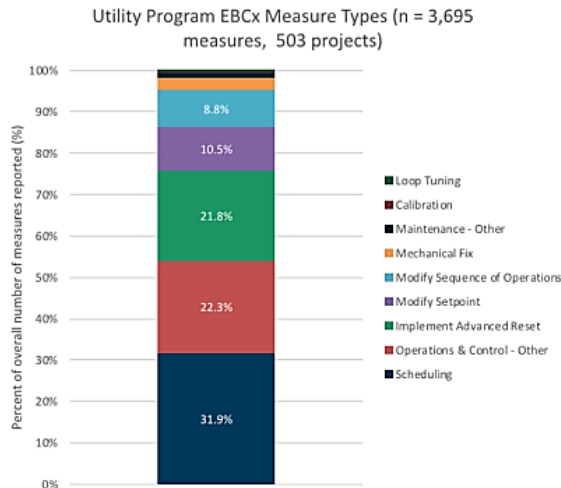


Figure 24. Top Measures implemented in EBCx (LBNL Data Survey)

These controls adjustments are typically addressed by the controls contractor, by in-house personnel, or by the commissioning provider. When mechanical fixes are required, those are often addressed by in-house personnel or the mechanical contractor. It should be noted, however, that having a controls contractor on the team is necessary in many cases to address complex issues. Figure 25 shows the weighted average of frequency where issues were discovered during EBCx investigation, and who followed up to address them. Investigation issues were often prioritized by cost during this phase (see section on *EBCx Economic Issues*).

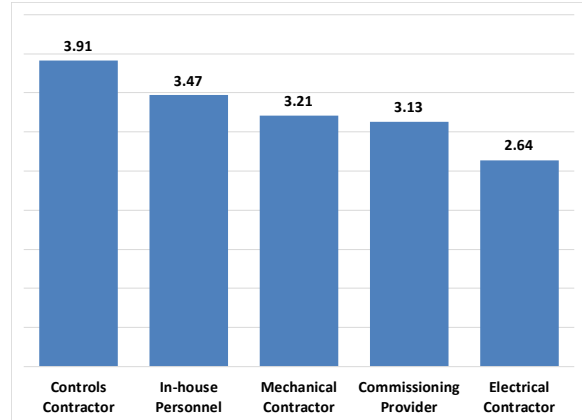


Figure 25. Who implements EBCx recommendations?

Training

One of the benefits of the EBCx process is providing additional training to facilities personnel about the operation of their building systems. We asked, how often does the typical EBCx scope emphasize systems training for facility personnel? From the survey results, approximately 45 percent of respondents include training consistently in their EBCx process. Over 75 percent of the projects included training more than “Sometimes”, indicating that the need for facilities personnel to understand their systems’ functionality and integration is important.

For comparison, the results from the building data survey show training as an element in implementing EBCx in almost 40 percent of the responses, somewhat less than this Market Survey indicated (compare to Figure 18).

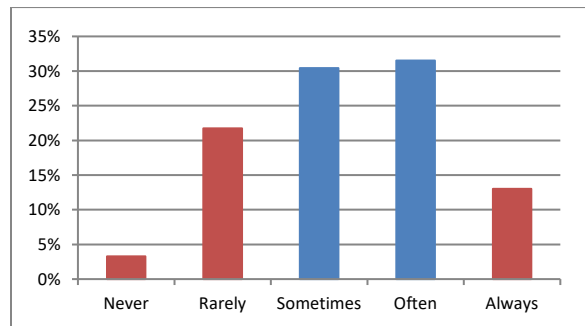


Figure 26. How often is training emphasized in EBCx scopes?

EBCx Economic Results

To identify energy savings and return on investment, respondents were asked to estimate verified energy savings and average payback for their EBCx projects. These questions do overlap similar responses from the LBNL Data Study. The purpose here was to provide more background to the economic results attributed to non-utility program EBCx projects.

Energy Savings

The weighted average of energy savings for EBCx projects was over 12 percent. As shown in Figure 27, nearly half (46 percent) of projects were estimated to be in the range of 10 to 20 percent energy savings. When compared to the results of the LBNL Data Study, the median energy savings for *non-utility program* EBCx projects was 14 percent.

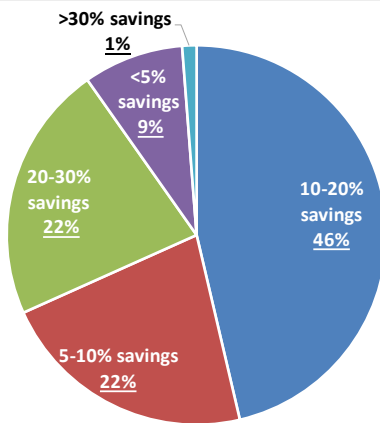


Figure 27. Range of verified EBCx energy savings (BCxA Market Study)

On the other hand, LBNL Data Study results show a median of 6 percent energy savings, shown in Figure 28. The correlation of the results of the two studies provides confidence that energy savings in the range of 5 to 10 percent is available for utility EBCx programs, and could be between 10 to 20 percent in non-utility programs. The additional energy savings does require additional scope and costs to achieve, which has an effect on overall economic payback of the EBCx process.

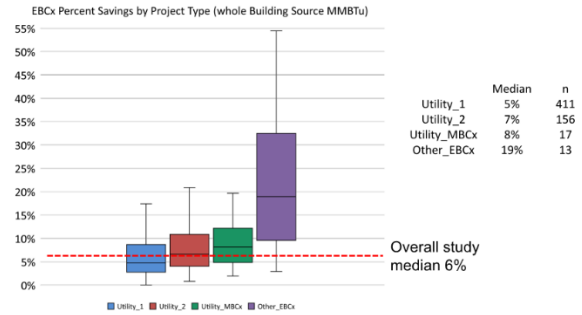


Figure 28. EBCx Energy Savings (LBNL Data Study)

The comparative results imply that energy savings resulting from utility-sponsored EBCx projects are less. This Market Survey results tend to follow the higher energy savings associated with a larger mix of non-utility programs. Either way, the appeal of utility incentives or the short economic payback period from EBCx can help encourage owners to implement the EBCx process.

Return on Investment (Simple Payback)

Market survey respondents estimated that the average simple payback for their projects ranged mostly from 1 to 5 years, with a weighted average of 1.5 years. The simple payback from this Market Survey (Figure 29) also compares favorably with the results of the LBNL Data Study results shown in Figure 30.

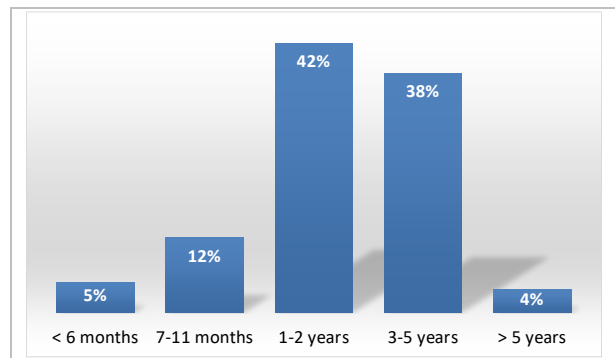


Figure 29. Estimated Simple Payback (BCxA Market Study)

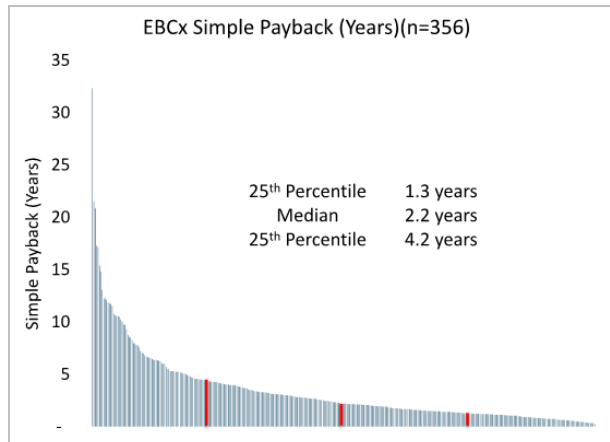


Figure 30. Simple Payback (LBNL Data Study)

Thus, in general, there is strong confidence that EBCx processes can result in a simple payback in the range of 1 to 5 years, even with a diversity of building types and sizes and EBCx delivery methods.

The simple payback values reported in this Market Survey for EBCx projects are also comparable to OCx projects, as shown when comparing the results from both. The results for EBCx were compared to OCx (Figure 31) to provide context for this emerging market.

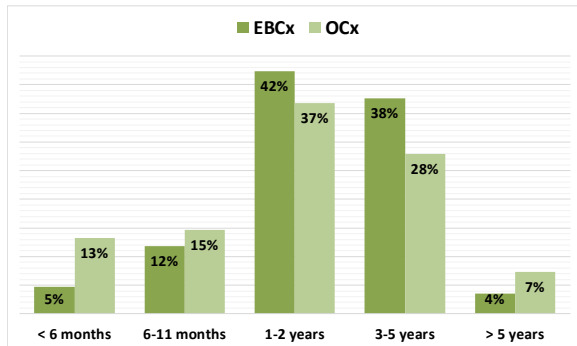


Figure 31. Simple Payback comparison between EBCx and OCx

When issues were discovered during the investigation phase, this Market Survey indicates, not surprisingly, that the highest percentage of issues addressed during EBCx were those with the shortest payback period. Insight can be gained by reviewing a further breakdown of the results in Figure 32.

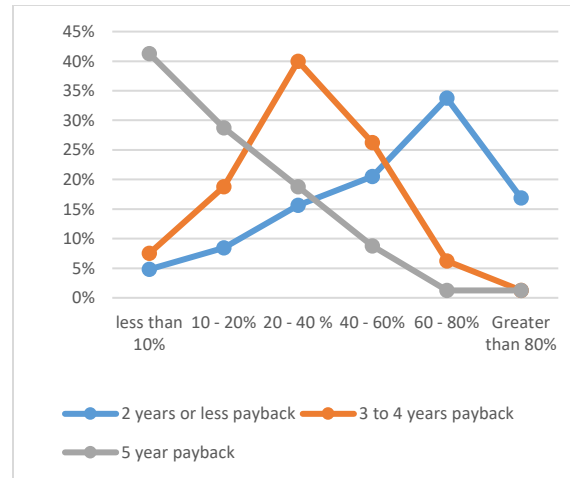


Figure 32. Percentage of EBCx project implementation (by range of simple payback)

In other words, the simple payback period of EBCx issues identified by respondents correlated with the frequency of addressing identified EBCx measures. Here are the weighted averages for the three payback scenarios:

- **2 years or less.** EBCx issues that fell into this category were addressed more than half (over 55 percent) of the time.
- **3 to 4 years.** EBCx issues that fell into this category were addressed about one-third of the time.
- **5 years or more.** EBCx issues that fell into this category were addressed only 18 percent of the time.

EBCx issues with a 2-year simple payback or less continue to be a favorable threshold for building owners to consider EBCx (i.e., low-hanging fruit).

ONGOING COMMISSIONING

This segment of this Market Survey was intended to assess the level of ongoing commissioning market penetration, the factors that influence its uptake, and provide feedback on the understanding, economics, prevalence and process of Ongoing Commissioning (OCx).

OCx, by definition, collects and analyzes data over time. The promise that OCx can rely on both scheduled manual activities and technology that consistently measures, verifies, and notifies facility staff to optimize energy and lifecycle performance are attractive features. OCx is intended to provide operation and maintenance information to help make facility performance management easier and, in advanced projects, to actually adjust or optimize integrated systems-level performance. The ultimate benefit to owners results in potential building systems lifecycle, human resources, energy and cost savings.

However, OCx has yet to be fully adopted by owners, who may perceive that the OCx process involves additional work as well as scarcely available time and resources to execute.

OCx Market Factors

The survey did not define OCx for respondents, but rather explored marketplace understanding of OCx as a practice. The upcoming ASHRAE Guideline 0-2019: The Commissioning Process, completed its public review period in May 2019, and has revised the definition of OCx as follows:

“Ongoing Cx Commissioning Process: A continuation of the Cx well into occupancy and operations to continually improve the operation and performance of a facility to meet current and evolving CFR or OPR. Ongoing Cx Activities occur throughout the life of the facility; some of these will be close to continuous in implementation, and others will be scheduled or unscheduled (as needed).”

Ongoing commissioning is a new and extended practice of the commissioning process. The use of monitoring-based data collection and analysis instruments, such as EMIS (energy management information systems) is starting to receive recognition for acquiring long-term savings. However, OCx as a continuous implementation

process has not yet been executed on a large scale across the nonresidential sector.

In this Market Survey, nearly 75 percent of respondents reported performing OCx in one building or none at all.

When asked how long respondents’ firms have offered OCx, there were far fewer total responses compared to EBCx and NCCx—with 43 respondents skipping the question altogether—implying that many firms providing new construction and existing building commissioning may not have yet adopted OCx into their service portfolios. Figure 33 lists a breakdown of providers’ longevity in the OCx space:

Years	
Less than 1 year	20%
1-2 years	28%
3-5 years	26%
5-10 years	16%
Over 10 years	11%

Figure 33. How long has firms provided OCx services?

To determine whether OCx was undertaken as first-time commissioning or as an extension of the owner’s commissioning plan, we asked if respondents’ projects had been previously commissioned.

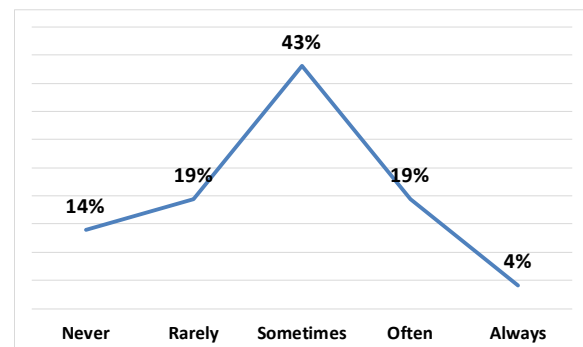


Figure 34. How often were OCx projects previously commissioned?

Twenty-three percent of respondents indicated that buildings had been previously commissioned “Often-Always.”

The implementation of the OCx process has been focused on mechanical systems, but integration of lighting controls and utility meters are increasingly common scopes for OCx, which is typically intended to capture energy and cost savings across all building systems.

One takeaway that needs further investigation is this: what is/are the definition(s) of OCx in current project terms? Respondents who say they have offered OCx to owners for more than 5 years may be conducting services to meet LEED v4 monitoring-based commissioning (MBCx) requirements – or earlier LEED “Enhanced Cx” requirements. They may be providing warranty period services for new construction or existing building commissioning jobs, or are being hired by the owner to assist or facilitate operations personnel.

Respondents indicated that more than 50 percent of OCx projects were not renewed after the first 12 months and, at the other end of the spectrum, only 6 percent said their projects were renewed 80 percent of the time.

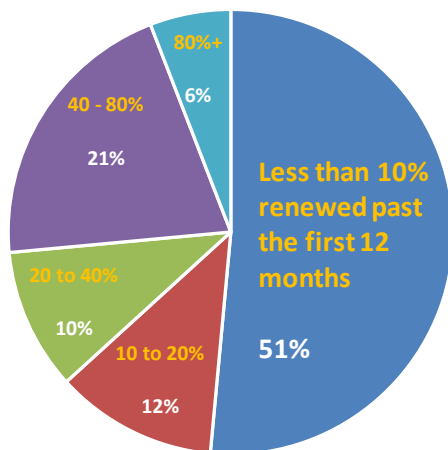


Figure 35. How many OCx projects were renewed past the first 12 months of the service?

The majority of respondents said they have started offering OCx services within the past 5 years or less, compared to EBCx services which many firms have offered for 10 years or more.

Building owners are generally slow, if not resistant, to embrace ongoing commissioning as a valuable building operations tool/process. When asked how often respondents find owners embracing OCx and making it part of their future O&M processes, 43 percent indicated “Rarely” or “Never”, as shown in Figure 36.

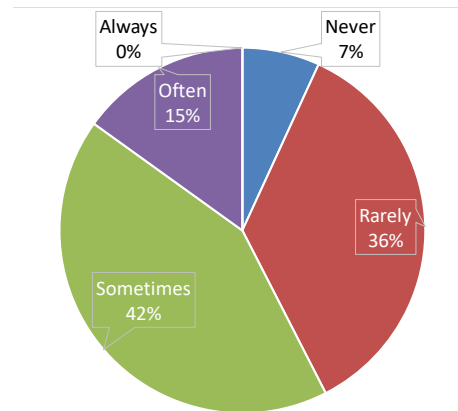


Figure 36. How often do owners make OCx part of future O&M processes?

Compared to the NCCx and EBCx markets, the OCx market is immature, and work is under way in research sectors and pilot programs to provide stakeholders with demonstrable value in terms of energy savings and return on investment. Commissioning providers who do engage with clients in OCx are in a position to help clarify and promote the purpose, process and outcomes of commissioning over time.

OCx Process and Scope

The scope of OCx work beyond NCCx or EBCx may include the construction warranty period or existing building systems warranty but, according to the ASHRAE definition, “Activities occur throughout the life of the facility.” OCx is both a whole building and a systems-specific approach to savings and performance.

Investigation

As with EBCx, owners usually request an energy analysis to determine if issues discovered during an OCx investigation should be addressed in or before the implementation phase. Exactly 50 percent of responses included *economic analysis* most of the time, and 82 percent of responses use *energy analysis* at least “Sometimes.” At least some level of energy analysis is generally required before implementing energy savings projects in existing building scenarios, whether for EBCx or OCx.

This Market Survey asked how often an automated fault detection and diagnostics (FDD) scope is included in addition to energy information

dashboards. FDD was “Rarely” included in the respondents’ OCx projects. Over 60 percent included FDD “Rarely” or “Never.” The majority of the advanced (using equipment/software beyond the building automation system) OCx scope revolves around gathering energy information and analysis. As OCx continues to evolve, it is expected that incorporating FDD will increase, but that has materialized as a common OCx scope item in a minority of respondents’ projects.

Implementation

The table below provides details on the results on how often different stakeholders are used in the process of implementing OCx hardware and software.

	Never	Rarely	Sometimes	Often	Always
Controls Contractor	7%	13%	24%	42%	14%
Commissioning Provider	28%	19%	21%	24%	9%
Other (Describe)	53%	0%	20%	20%	7%
Facility Personnel	30%	33%	32%	4%	0%
Mechanical Contractor	47%	22%	22%	7%	1%

Figure 37. Who performs installation of OCx hardware/software?

When asked directly “who” performed the installation and integration of OCx hardware and software, the survey shows that integration of OCx hardware is primarily accomplished by the controls contractor, with over 56 percent being used “Often-Always”. The commissioning provider is the second most common resource for installing OCx hardware and software. Facility personnel and mechanical contractor are also involved during the installation on rare occasions.

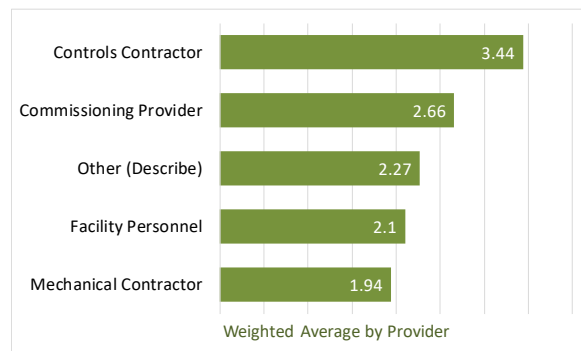


Figure 38. Who performs installation of OCx hardware/software (weighted average)?

The “other” category in Figure 38 above included vendor installation and, in one case, the owner purchased and installed the equipment, which then needed to be rechecked in detail after it was found to be reporting incorrectly.

When asked “who” was most likely to address issues and deficiencies discovered during the OCx investigation phase, the controls contractor was named most often, as shown in Figure 39.

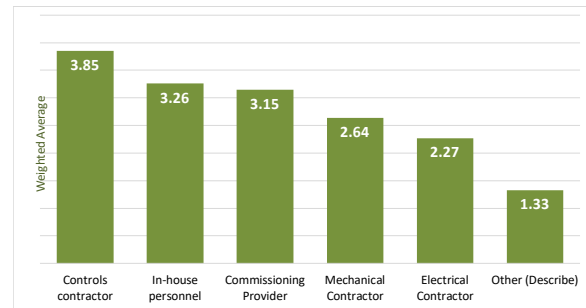


Figure 39. Who addresses issues discovered by OCx process?

The in-house operations staff is also used often, which indicates that repairs or modifications are usually not significant enough to require outside contractors.

Controls contractors are, as one might expect, included “Often-Always” most of the time (74 percent of responses). Figure 40 provides details of results on how frequently different stakeholders are used to implement ongoing commissioning.

	Never	Rarely	Sometimes	Often	Always
Controls Contractor	2%	5%	20%	56%	18%
In-house personnel	1%	13%	44%	40%	1%
Commissioning Provider	7%	19%	32%	34%	7%
Mechanical Contractor	17%	23%	42%	17%	2%
Electrical Contractor	24%	33%	35%	6%	2%
Other (Describe)	67%	33%	0%	0%	0%

Figure 40. Who addresses issues discovered by OCx process? (detailed breakdown)

The OCx process provides (continuous or regular-intermittent) feedback on the performance of facilities and on recommendations for implementing repairs to improve efficiency. Follow-up reviews of facility performance, after the initial OCx investigation is completed, were most often conducted quarterly, as shown in Figure 41.

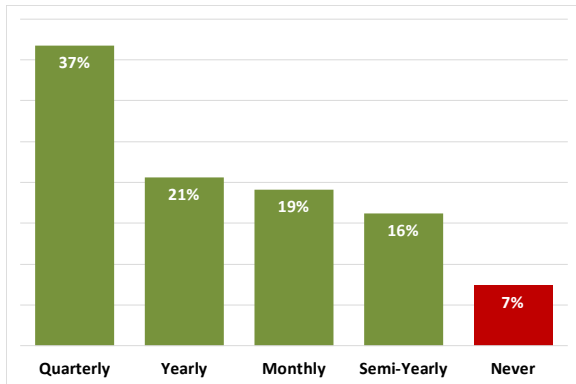


Figure 41. How often are OCx results reviewed with owner?

Frequent review of results is a best practice with the OCx process.

OCx Economic Results

Overall survey results suggest that owners have not yet recognized the value of OCx to invest long term, and OCx processes have not yet become part of the core O&M process in operating facilities.

The opportunity for EBCx and OCx providers, along with associated systems vendors, to educate owners about the value proposition for OCx is ripening as market pressures escalate, such as benchmarking, data-driven energy efficiency reporting mandates, resource performance requirements, codes, occupant/tenant comfort and safety).

Cost, Payback and Savings of OCx

The cost of implementing the OCx process occurs mostly up-front, during initial setup. The following responses summarize the economic results for OCx projects. For several questions, the results for OCx are compared to EBCx for context within this emerging market.

The average simple payback applied to OCx has a weighted average of 1.5 years, with a range between 1 and 5 years. The simple payback values reported for OCx projects are relatively comparable to EBCx projects. Figure 42 (also presented in Figure 31, EBCx Section) compares what respondents experienced as average simple payback achieved by OCx and EBCx projects:

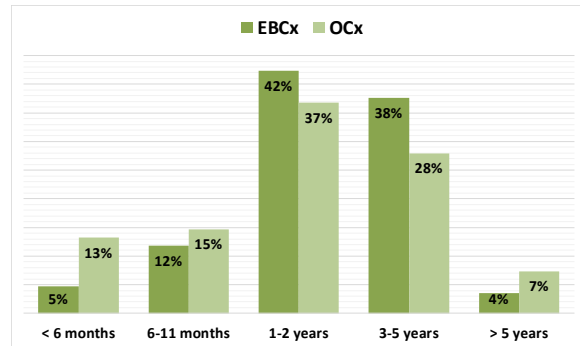


Figure 42. Simple Payback comparison between OCx and EBCx

According to respondents, OCx has achieved greatest energy savings with a simple payback of less than 2 years, with significant savings within the first year. This may be an indication of respondents interpreting OCx as post-turnover during the first-year warranty. However, even for established EBCx utility programs, incentives are often not provided to implement projects with simple payback results as attractive as this. Like net metering, the utility OCx subsidy could become a victim of its own success.

Program incentives. Some states, municipalities, utilities, and industry allies in the U.S. and Canada have developed financial incentives and technical assistance programs to encourage adoption of system-level OCx tools, such as energy management information systems (EMIS) for monitoring-based commissioning (MBCx). For example:

- ComEd
- Pepco
- NYSERDA
- State of Kentucky
- California University/IOU Partnership
- Massachusetts MASS Save Program

However, the majority of program providers have not fully embraced OCx. Utility and larger-scale programs, especially those offering incentives, rely on proven results before developing their programs' financial structure. Secondly, their ability to market programs successfully depends on ROI and other evidence of costs and savings that are only recently being tracked over time; thus, the history of OCx benefits is not deep and the perception of high cost/risk still prevails.

The survey indicates that utility incentives (beyond EBCx scope) were never available about 25 percent

of the time, and “Always” available only 3 percent of the time, as shown in Figure 43.

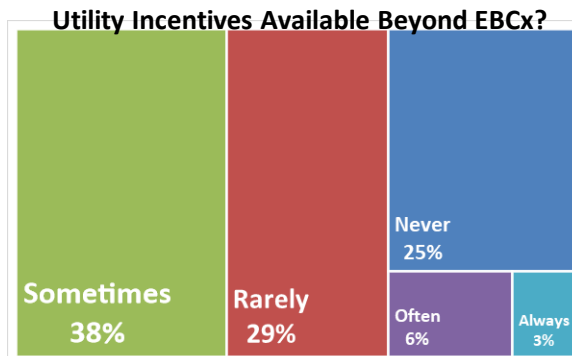


Figure 43. Were utility incentives available for the OCx scope?

The most likely reason for rebates or other financial incentives being available “Rarely” or “Never” (54 percent of the time), or just “Sometimes” (38 percent) is lack of an accessible or available program.

Utility programs typically target projects that produce demand (kW) energy savings, compared to energy consumption (kWh) savings. Where they do exist, OCx programs emphasize improving performance to produce energy consumption savings; thus, OCx programs may not necessarily fit the goals of utilities’ integrated resource plans. That said, regulatory bodies are placing ceilings on energy use in buildings, putting pressure on stakeholders across the market to meet increasingly strict conservation goals.

Many program providers are still researching whether the newer technology will provide resilient energy savings. Since the OCx process produces verifiable results, confidence in the reliability and resilience of energy savings will increase as the process and technology are applied in the future.

Like EBCx, the OCx process aims to discover and resolve deficiencies and optimize systems to obtain energy savings and quality performance. The majority of responses indicated that the implementation of repairs and measures identified in the OCx investigation resulted in an economic payback of less than 4 years.

We compared EBCx and OCx average verified energy savings achieved by respondents’ projects. Figure 44 shows that there is a similar bell curve for both.

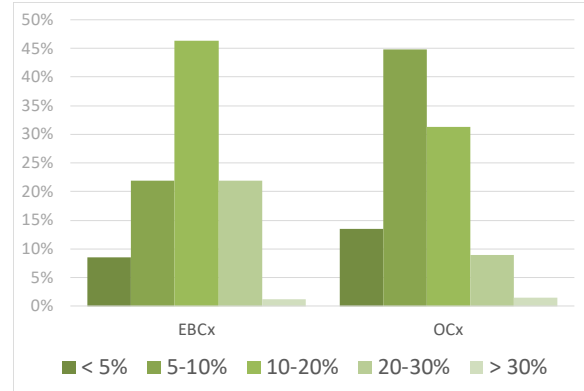


Figure 44. Energy savings comparison for EBCx and OCx processes

When asked about issues discovered during OCx investigation, respondents indicated that the majority of issues with a 2-year or less payback were most often addressed, followed by a 3-4 year payback. However, the responses were unevenly distributed, as shown in Figure 45, indicating that payback was most likely project-specific.

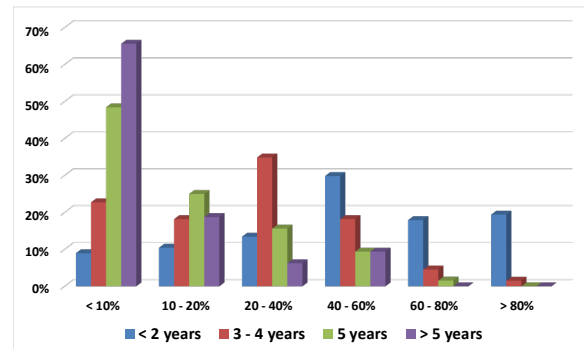


Figure 45. Percentage that OCx issues were address, depending upon range of payback

It should also be noted that EBCx savings reflect a specific point in time, whereas OCx savings are cumulative and incremental throughout the life of the OCx process.

Results from the following and other OCx-related studies indicate that both cost and energy savings are achievable by monitoring and tuning or correcting building systems issues as they occur.

- [Smart building monitoring and ongoing commissioning](#): A case study with four Canadian federal government office buildings. Source: National Research Canada.

- [Where's the Beef in Continuous Commissioning?](#) Results from 140 Buildings in Commercial Property and Higher Education. Source: ACEEE
- [Energy Conservation through Ongoing Commissioning](#): Source: Schneider Electric Field Case Studies
- [Smart Energy Analytics Campaign](#) Ongoing Commissioning Case Studies, Source: US DOE
- [Building analytics and monitoring-based commissioning: industry practice, costs, and savings](#): Source: Energy Efficiency; Kramer, Hannah et al, 2019
- https://betterbuildingsinitiative.energy.gov/sites/default/files/attachments/EIS_costs_benefits_report.pdf: Source: US DOE

Summary

What does this all this mean? Survey respondents indicate that the OCx process resulted in energy savings across a range of 5 to 20 percent, with a weighted average of **8 percent**. For comparison, the EBCx process reports slightly higher range of energy savings, with a weighted average of approximately **12 percent**.

There is confusion in the market about what ongoing commissioning is and does, and what technologies exist beyond the building automation system. Energy Management Information Systems (EMIS) applications have expanded their capabilities to include real-time energy data, fault detection analysis, demand response, and energy procurement. While these applications are designed to give detailed insights into higher energy savings, barriers such as first cost, lack of awareness, and uncertainty about benefits exist, which prevent the commercial sector from realizing the savings potential.

Increasing Market Uptake

In a recent survey, the Institute for Market Transformation (IMT) asked participants how utility and government authorities could steer them toward market awareness and actively managing their energy consumption. From the IMT survey respondents, three needs were stressed: education, incentives, and regulation.

To increase market uptake, service providers, government entities and energy efficiency program implementers should examine how they can break

down the barriers stakeholders face against using ongoing commissioning.

RECOMMENDATIONS FOR NEXT STEPS AND INTELLIGENCE GATHERING

As we reviewed the respondents' answers, we considered the potential of a next-phase Market Survey based on the important issues raised. We are developing a preliminary list of issues that will help commissioning providers and building industry stakeholders.

What Do You Think?

We want your suggestions! Among the topics that deserve further inquiry, the following are surfacing:

- Deeper dive into Cx participation throughout the project design-construction-operation process.
- More concentration on areas of increasing responsibility for CxPs.
- Technologies that are significantly impacting and improving (or not) the commissioning process.
- More emphasis on building enclosure (envelope) commissioning.
- NCCx, EBCx and OCx best practices as viewed by CxPs and other project team members.

Members of the building community – from owners to designers, contractors, subcontractors, code officials and all – are encouraged to weigh in on these topics by contacting the Building Commissioning Association at <https://www.bcx.org/contact/>