CONCEPT TO CONSUMPTION:

Outcome-based oversight of building performance

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It's an unfortunate reality that efficiently designed buildings often use more energy than they were intended to use – sometimes substantially more. This means owners can end up paying twice for their investment – once upfront for the more expensive, high-performance equipment and then again for unnecessary energy use if the building does not perform as designed.

Subpar building performance can occur for numerous reasons and can be set in motion at any point from day one of planning all the way through design, construction, and operation. Failure to establish an energy goal, an absence of commissioning, an unprepared facility staff, faulty equipment, incorrect installation, a lack of measurement and verification – these pitfalls and more can lead to systems operating inefficiently, difficult-to-trace issues, and, ultimately, added energy costs.

This executive guide outlines a new, wholistic project oversight method that protects an efficiently designed building from the many shortcomings that can lead to poor performance – thereby reducing the financial risk for owners who invest in high-performance design. The information in this guide provides a high-level introduction to the key components of this method with the understanding that every project will have unique parameters requiring a more in-depth development of the process to achieve successful implementation.

Concept through Consumption

Unlike typical design and construction projects that end at occupancy, this proactive and collaborative oversight spans a building's life cycle, from concept through consumption. In its most successful form, the owner hires a consistent partner to safeguard performance and oversee the entire process. This "best in class" method focuses on the targeted operational performance of a completed building (instead of relying solely on the design's energy model) and leverages data to hold the entire team accountable to an outcome-based goal. Architect, engineer, general contractor, owner, and commissioning agent all understand that the project is not complete until the expected performance is seen in operations.

Recent advances in energy monitoring and data analytics make concept-to-consumption oversight readily available and enable design and construction teams to collaborate on a higher level to provide owners with more value. It works in tandem with full-design, design-bid-build project delivery, as well as with alternative delivery methods (particularly design-build) to give the owner confidence that they will receive the desired energy outcome.

In addition, owners of multiple facilities may find concept-to-consumption oversight more

transformative for their overall operations than going "all in" on a few high performance or net-zero projects (which can be financially prohibitive).

With the performance culture of any building typically well established by the end of the first two years of operation, concept-to-consumption oversight proactively sets a "good habit" for the building at the very beginning of operation – and then gives the building the support it needs to perform well throughout its life. This is accomplished through the implementation of four critical steps in the life of a building project:

- CONCEPT ANALYSIS AND GOAL SETTING
- DESIGN
- COMMISSIONING
- CONSUMPTION ANALYSIS AND OPTIMIZATION

Having a consistent partner provide oversight through these steps ensures continuity, keeps the outcome-based performance goal front and center, and eliminates the "cold hand-offs" from one stakeholder to another that traditionally occur at the end of each phase of a project.

Concept Analysis and Goal Setting

A new building's path toward successful outcome-based performance begins with setting a clear, quantifiable energy goal. Concept-to-consumption oversight achieves this by identifying and targeting the building's desired energy use intensity, or EUI.

EUI is a building's demonstrated annual energy use per unit of area, typically measured in kBtu/square foot/year. (Think of it as a "miles per gallon" for your building.) It usually refers to site energy use and is used to compare performance of buildings of various sizes, types, and locations. An owner can set an EUI for a new building using early conceptual energy modeling and a variety of benchmarks, e.g., the performance of similar buildings, the performance of the owner's other buildings, Energy Star buildings, etc. The EUI may then be included in the project's RFP and contracts. *(For more information, read, "Putting the EUI in the RFP," at right.)*

Making performance a single, measurable number removes ambiguity, and instead of basing decisions on first cost alone (at the possible expense of quality, performance, and life-cycle cost savings) the team is guided by *both* first cost and impact on EUI. At the end of the project the building's actual EUI is assessed post-construction. If the target wasn't achieved, the design and construction team works to understand why and correct it before contracts are completed and warranties have expired.

Putting the EUI in the RFP

Once an owner has established an energy use intensity (EUI) goal for their project, they should not only state the goal in the RFP but also include language that enforces its achievement. Sample language, based on the approach the owner wishes to take, includes:

- **NEUTRAL, with no penalty or financial implications for not meeting the goal.** Example: "Provide electric and gas usage and site and source EUI for each of the two years subsequent to occupancy for verification of energy performance. Provide two-year water usage for each of the two years subsequent to occupancy for verification of system performance."
- **INCENTIVE-BASED, giving the design team a fraction of the money the owner will save when the goal is met.** Example: "Owner shall offer a pre-determined incentive amount during the Performance Guarantee Period. Release of payment for this amount shall be contingent upon confirmation that the operations, maintenance, and energy use intensity (EUI) performance standards have been achieved and verified."
- **RETAINAGE-BASED, withholding a fraction of the construction fee until the energy target is achieved.** Example: "The owner shall retain a pre-determined amount of dollars from the overall contract award during performance evaluation. Release of payment for this withheld amount will be contingent upon final confirmation that the energy performance standards have been achieved and verified."

For more information, watch the video, "Putting the EUI in the RFP."

Design

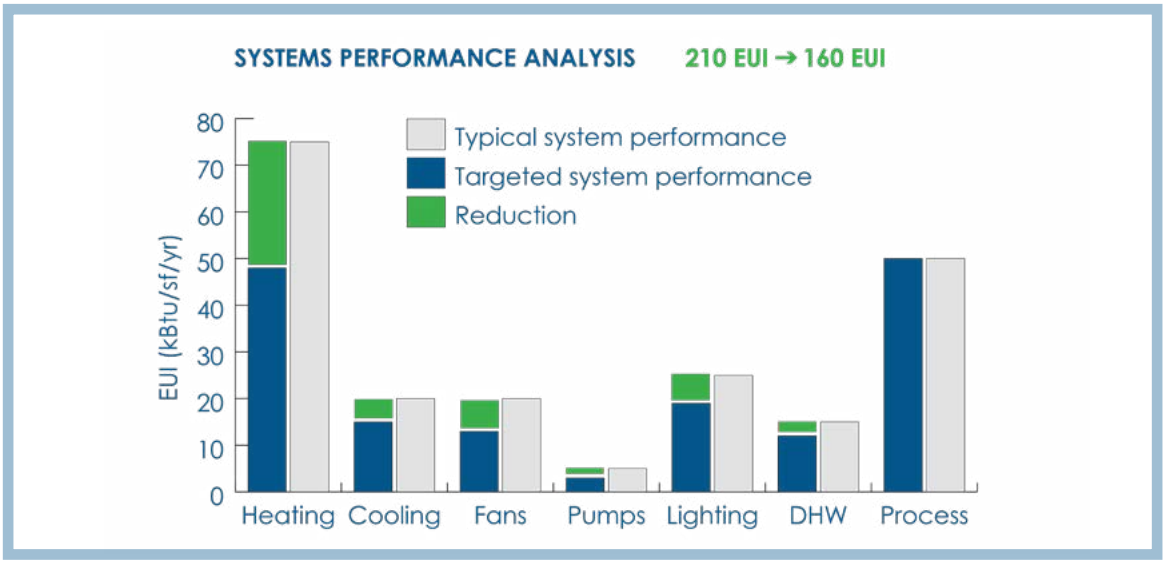
This component of the performance oversight method develops the project's concepts into clear and specific design documentation. These documents specify the solutions that will achieve the stated EUI goal and provide the means to evaluate actual building performance. This is accomplished by:

CLARIFYING THE ASSUMPTIONS FOR EVALUATING THE BUILDING. Discussions with the owner should lead to full understanding of the use of the building, which will help determine the key items of focus for achieving the desired EUI. What are the building's primary functions and programming? What is its schedule? For example, being operational seven days a week versus five days a week will affect the EUI and can make a difference in which measures are prioritized to attain the desired outcome.

DOCUMENTING THE DESIGN INTENT. Everything that affects the building's energy performance must be clearly defined and documented for clear understanding. This includes equipment specifications, design intent, how operations will be monitored, and how the gathered data will be used.

ESTABLISHING AN ENERGY BUDGET. Just as all physical components of a project (architectural, mechanical, electrical, etc.) are given a portion of the overall construction budget, the building's key systems should be given a portion of the end-use "energy budget." This is a key step in the concept-to-consumption process that is typically missing in most projects. For example, lighting, heating, etc., each can be allotted a specific amount of energy. If during operations the total EUI is higher than the goal, submeter monitoring will show which systems are meeting their individual energy budget and which are not – giving the team a clearer, easier way of identifying the problem system and a quicker path to correcting it.

DETERMINING SYSTEMS TO BE MONITORED. While it's overwhelming and too expensive to monitor every system, the team should identify and monitor the five to seven key items with the largest effect on overall building performance. This goes beyond simply monitoring utility consumption (gas, electricity, steam, chilled water) and includes submeters that break out power consumed by individual systems such as lighting, HVAC, plug loads, etc. – any end uses with an established "energy budget." Plans for gathering and using the performance data also are established and documented during this step.



Key systems should be assigned a portion of a building's targeted EUI (set at 160 in the chart above, compared to a similar building EUI of 210). This, along with submeter monitoring, makes it easier to identify systems that are not performing as designed should the total building EUI exceed the target during operations.

These four actions ensure the discussion and documentation are in place so that everyone – owner, design team, contractor, commissioning agent – understands how the building is intended to be used, how it is expected to perform and under what set of conditions, and how the performance will be monitored.

Commissioning

Commissioning ensures that building systems are operating as designed and intended, and when utilized the process is the same for any new building. In a concept-to-consumption approach, specific commissioning tasks occur in conjunction with concept analysis and goal setting, design, and consumption analysis. A concept-to-consumption project also typically will have more measurement and verification (M&V) systems and devices to be included in the commissioning work.

The key actions of commissioning, grouped by project timeline, are:

DESIGN: Commissioning requirements are integrated into the bid documents and the commissioning agent helps confirm that project needs stated in the Owner's Project Requirements (OPR) document are reflected in the design documents. In addition:

- The plan for measurement and verification of the building operation is developed.
- M&V systems and equipment are confirmed and included in the project plans and specifications.

CONSTRUCTION: Systems installation is observed to verify compliance with the design documents. In addition:

- Project documentation such as changes and shop drawings are reviewed.
- Functional performance tests are created.
- M&V equipment and instrumentation are verified.

ACCEPTANCE TESTING: Functional performance tests are conducted, and results are documented. In addition:

- Observed operation failures identified during testing are tracked and corrected.
- M&V equipment and systems are confirmed to be gathering and reporting data accurately.
- Documentation of the entire commissioning process is compiled in a report.

OCCUPANCY AND OPERATION: Facility staff is assisted in the transition into ownership and operation. In addition:

- Systems operation and maintenance manuals are provided with clear and specific documentation for staff use.
- Systems training is conducted to ensure operators understand the building design and operation intent.
- M&V and fault detection systems data collection and trending are underway.

Consumption Analysis and Optimization

With the building constructed per the design and commissioned, like a newly built and christened ship the building is "set out to sea" to see how it performs. Consumption analysis begins once sufficient building operating data has been collected; a good time for the initial look at energy performance is at eight months post occupancy – prior to the expiration of the typical one-year warranty with the contractor. Since most owners don't have the staff to conduct post-occupancy consumption analysis, having the concept-to-consumption partner provide this function as part of the overall project performance oversight is essential for "closing the loop" on the entire process and providing feedback for the owner to act upon.

Once the building has passed its startup period and collected 12 months of reliable data (typically 18 months after substantial completion), a more detailed performance analysis is completed. This analysis evaluates and calibrates the data and compares the results to the target EUI set at the earliest stage of the project. Should the analysis uncover energy use that is above the target, the cause(s) can be more easily identified due to the submeters set in place to track energy use of key systems. Corrective measures can then be taken, with continued M&V to ensure the corrections are effective.

Owners who want to take this process a step further can consider monitoring-based commissioning (MBCx), or fault detection diagnostics, which provides analysis for the life of a building. This process employs additional software integrated with the building automation system (BAS) to monitor key parameters and characteristics of the building. The purpose is to identify any less-than-optimal operating conditions causing additional energy consumption that might otherwise go unnoticed, with responsive maintenance enacted to prevent further wasted resources, occupant discomfort, air quality issues, and damage to equipment.

A 2019 Department of Energy study estimates typical savings from MBCx to be 9% of total energy use, around $0.24/sf. Once cost-prohibitive for buildings under 500,000 square feet, the emerging ease of data access, reduced cost of sensor equipment, and automation of monitoring software has made MBCx a cost-effective option for buildings as small as 50,000 square feet.

> "With analytic software applied to everyday building operations, owners are using data to their advantage and realizing cost savings."
>
> -- U.S. Department of Energy

Outcome-based oversight in action at Marston Hall

The recent LEED Gold renovation of Marston Hall at Iowa State University utilized concept-to-consumption oversight (provided by IMEG as part of the firm's MEPT design work on the project). When first-year energy reports showed that the building was using more energy than the original LEED energy modeling analysis had estimated, consumption analysis revealed that a malfunctioning steam pre-heat coil control valve was inflating both chilled water and steam energy use unnecessarily.

Had monitoring and analysis not been included in the project, the issue could have gone undiscovered indefinitely. However, by being proactive in managing its energy, the university was able to identify and correct the faulty control valve operation – saving about $24,000 ($0.40/sf) annually in unnecessary energy use (and recovering its one-time investment for concept-to-consumption oversight in the first year).

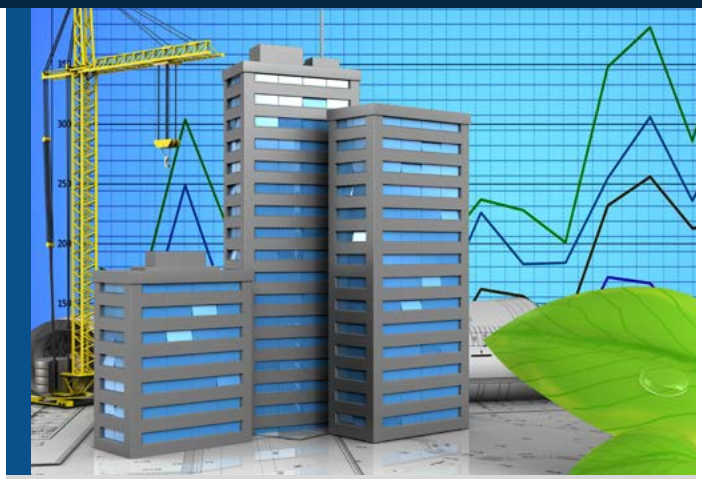
Read the full case study.

The bottom line

Utilizing EUI-driven, concept-to-consumption oversight results in a lifetime high-performance building "culture," reliable and fully understood systems for operations and maintenance staff, and mitigation of financial risk – i.e., assurance that the owner's investment in high-performance technology will provide the expected EUI and ROI.

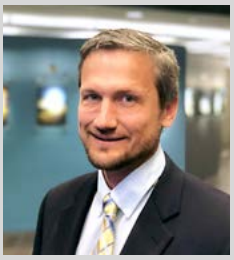
Engaging a consistent partner to guide a project from concept to consumption does require an investment by the owner, but at a fraction of the overall project cost, with a short payback and a lifetime of savings – especially considering that over a building's lifespan its operation and maintenance costs often reach three times its initial construction cost. (Large dividends also can be realized when adapting this approach to be utilized on existing buildings.)

It all comes down to the adage that if you don't measure it, you can't manage it – and, by extension, you can't save yourself a substantial amount of money in unnecessary energy costs.



More information

To learn more about concept-to-consumption oversight services, contact the authors:



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