

TECHNICAL FEATURE

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University of Chicago Campus North Residence Hall and Dining Commons.

Procurement Path for Energy-Efficient Buildings

BY ADAM MCMILLEN, P.E.; PAUL TORCELLINI, PH.D., P.E., MEMBER ASHRAE; SUMIT RAY, P.E.; AND KEVIN RODGERS, MEMBER ASHRAE

In a perfect world, a building owner tells everyone what sort of building should be built. Talented design and contractor teams come together to design and build it. Twelve months later, the building performs to expectations, and the tenants are all happy. Utility bills match the design energy analysis. Simple, right?

Unfortunately, design and construction schedules are tight and decisions must be made in the need of the moment. Even with strong energy goals, not everyone bases decisions on the potential impact to those goals. The details of the building often are still being worked out after construction begins. So, how can we achieve a building that meets the owner's performance criteria? Which teams understand the value proposition and deliver the results? How do you encourage and motivate design and construction teams?

Some owners are taking a new approach to procure and achieve performance by using an absolute, measurable energy goal set at the beginning of the project, prior to design. In this article, we lay the framework for an emerging approach to establish and execute tangible energy performance goals. It is intended to simply introduce some base knowledge for when design teams see this requirement in an request for proposal (RFP) for the

first time. We will start with two new construction projects that blended a traditional design-build procurement process with a more open, collaborative approach. Future articles will dive deeper into these concepts and the impact on measured building performance.

The University of Chicago is now midway through the design of its 390,000 ft² (36 232 m²) residence hall. This project, scheduled for completion in 2016, sought an effective way to set a new construction energy performance-based target that they needed to hit to achieve campus-wide energy reduction goals. The National Renewable Energy Laboratory's Research Support Facility (RSF) project set out to demonstrate the integration of high performance design and procurement practices in a replicable manner. This 360,000 ft² (33 445 m²) Class A office building achieved both a stringent performance-based target and net zero design upon completion in 2010. Both projects had distinctive project

Adam McMillen, P.E., is director of energy consulting with the Energy Center of Wisconsin's Chicago office. Paul Torcellini, Ph.D., P.E., is the principal engineer for Commercial Buildings Research at NREL. Sumit Ray, P.E., is director, engineering and utilities, and Kevin Rodgers is university energy engineer, at the University of Chicago.

requirements and a common methodology to achieve real, measurable energy performance goals.

This new contract method also provides an incentive to build more efficiently, encourages the team to go beyond code requirement minimums, and provides an excellent return on investment with low risk. Here, the owner drives performance-based design from the initial scoping stage to allow design team flexibility to deliver a solution that the market can bear. In short, the building owner:

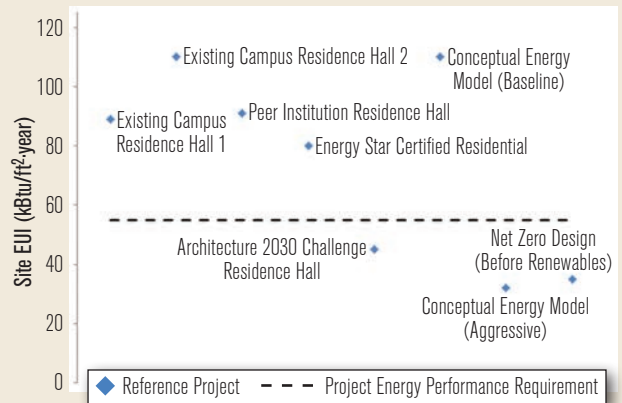
1. Sets a firm price for the project during program planning;
2. Specifies a whole building energy performance requirement;
3. Aligns program metrics with the performance criteria;
4. Assembles the request for proposal document;
5. Invites design-builders to propose solutions that best achieve the prioritized requirements;
6. Reviews energy analysis throughout project life; and
7. Measures the energy performance after substantial completion.

These seven steps (described below) set the framework that allows the owner to select the best design-build team that is responsible and accountable for designing, building, and delivering the project that meets the contractually proposed requirements. This is also achieved within a fixed schedule and for a firm-fixed price.¹ The power of the approach is in the simple clarity of the energy performance goal statement; it communicates a single number that is measured at the end of the contract. In this way, quality and operational efficiency can be measured just as easily as the procurement budget and project timeline.

1. Set a firm price for the project during program planning. Specifying an energy target should not impact the budget if the project enables feedback mechanisms toward what the market can bear. The question is simply reversed: “If this is my budget and I’d like to achieve this energy use intensity (EUI), what type of building and systems will meet both of these goals?” The two case studies provided in this article approached project budget in the same manner as traditional processes. It was established to be competitive with today’s standard energy efficient commercial and institutional buildings.

2. Specify a whole building energy performance requirement. Establishing a measurable performance goal is the key difference in this approach. On typical

FIGURE 1 Setting the energy performance target.



The energy goal should be tangible numbers that provide meaning to the project owner. One example scenario using several resources is provided above. The energy performance requirement (dashed line) can be confidently established after reviewing a number of additional resources (blue diamonds).

projects, budget and schedule is often held in strict communication, while actual energy performance is often handed-off to the facilities and maintenance group at substantial completion. A key component of this approach is that building energy performance remains with the procurement team. Since the project has a target value for energy consumption that is tracked throughout design and construction, the project can measure success once building operation is under way.

Establishing the target number can be flexible to the owner’s needs. Common metrics may include EUI (kBtu/ft²-year), absolute energy use (total kWh and therms), or independent utility consumption targets (electricity use in kWh/ft² and natural gas use in therms/ft²). Several projects have leveraged existing buildings in their portfolio, performance of their peers, building energy performance databases, and early conceptual energy models (Figure 1). In the end, the goal is to provide enough context to find a target with relevance to multiple owner needs. In contrast, many more traditional high performance design processes establish a number relative to some other intangible, unmeasured number (i.e., code baseline building model). This approach lacks the direction, communication, and persistence that the project requires. For example, stating that the building must have a site EUI lower than 55 kBtu/ft²-year (625 MJ/m²-year) is viewed, and executed, much more effectively than stating 30% better than ASHRAE/IES Standard 90.1-2010. For a goal to be met, the energy target must be an absolute and tangible number.

Aligning Program Metrics With the Energy Goal

The set of program metrics and performance criteria should be unique to each project. The program metrics for the National Renewable Energy Lab's RSF facility were as follows:¹

Mission Critical

1. Attain safe work performance and safe design practices
2. LEED Platinum rating
3. Energy Star appliances, unless other system outperforms

Highly Desirable

4. 800 staff capacity (later adjusted to 822)
5. 25 kBtu/ft² including NREL's data center
6. Architectural integrity
7. Honor future staff needs
8. Measurable 50% plus energy savings versus ASHRAE Standard 90.1-2004
9. Support culture and amenities
10. Expandable building
11. Ergonomics
12. Flexible workspace

13. Support future technologies
14. Documentation to produce a How To manual
15. PR campaign implemented in real time for benefit of DOE/NREL and DB (design/build team)
16. Allow secure collaboration with outsiders
17. Building information modeling
18. Substantial completion by June 2010

If Possible

19. Net zero design approach
20. Most energy-efficient building in the world
21. LEED Platinum Plus rating
22. Exceed 50% savings over ASHRAE baseline
23. Visual displays of current energy efficiency
24. Support public tours
25. Achieve national and global recognition and awards
26. Support personnel turnover

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3. Align program metrics to the performance criteria. Any good engineering problem is defined by specific dependent and independent variables. In setting three key independent variables (budget, time, and energy use), this new approach must then include other dependent variables to be able to arrive at a solution. Both projects presented here established tiered criteria to allow flexibility. In NREL's case, they established three levels:

- Mission critical: most likely viewed as independent variables, these are the metrics that are critical to the success of the project. The solution must include these.
- Highly desirable: primary goals that contribute to project success and owner satisfaction. If these are not included, the trade-offs should be made clear.
- If possible: highly beneficial if they are included in the solution.

This provided a framework for the goal and ultimately the contractor committed to "which" goal they were picking as part of their value added. A full list of NREL's RSF performance parameters can be found in the sidebar "Aligning Program Metrics With the Energy Goal," (Page 14) and is discussed in the NREL case study.

4. Assemble the request for proposal document. The owner must develop a clear, comprehensive RFP document when soliciting the design-build teams for the project. The program metrics, energy target definition, and project goals are clarified within the framework of their traditional RFP document. The importance of establishing this methodology within the RFP is critical to the project's success. Energy performance analysis and presentation can vary widely from one design team to the next. By establishing a protocol for the base supporting documentation, the design teams can communicate on common terms while still demonstrating their unique value proposition for the project.

5. Invite design-builders to propose solutions that best achieve the prioritized requirements. As seen in the case studies, using a design competition is the most effective approach for selecting the project team since it allows the owner to select the team that best meets project requirements. Using this approach the teams complete project submittals and in-person interviews that outline their proposed approach for meeting the project goals. Each submittal is then reviewed for typical procurement requirements and the energy performance criteria. Does the team fully understand the energy

performance criteria? Do their submittals reflect the experience needed to achieve the target? Does the stated energy use represent a realistic solution? It is critical that the review include an apples-to-apples comparison of the team's energy models in relation to the stated energy performance. This review can be completed by in-house staff or an independent, third-party consultant familiar with design and procurement practices.

6. Review the energy analysis throughout project life. Once the winning team is selected, the design process moves quickly into design development. Much of the idea creation and collaboration already occurred during the competition phase. The owner goals are already aligned with the project team's approach. Now the project can immediately start to bring the solutions to life. A primary change now is that the energy goal is communicated as often as the budget and timeline, perhaps more. It is reviewed and updated throughout the entire project life, from RFP to substantial completion. When project requirements and decisions are needed,

the owner and team now ask: 1) does it fit in the budget, 2) does it affect the construction schedule, and 3) how does it impact our final, absolute energy performance? Typically, only the first two are measured, now all three will be. Does this change the answer?

7. Measure the energy performance after substantial completion. Establishing the energy target ensures that the building begins on a high performance path. The RFP should also specify a predefined period when the owner and design/construction team review the actual building energy performance (i.e., 12 to 18 months). While performance is likely measured during the entire period, this stipulation provides a contractual hand-off where the owner's facility staff continues the high performance of the building. This period can provide a milestone for any incentive- or retainer-based provisions stated within the contract. It also provides a great transition point toward monitoring-based commissioning or other continuous maintenance programs. From a QAQC standpoint, it fine-tunes quality control

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throughout the process since the team knows that the model had to represent the as-built condition. This creates an effective commissioning and checking process by using one simple, measurable step.

Future of Performance-Based Design

Innovation arises when adversity, challenge, and great potential co-exist. These factors present the greatest motivation to change. When will the design and construction industry innovate to go beyond ‘what we did the last time’ and move toward grounded, tangible and accelerated goals? The case studies here reflect many success stories and lessons learned. The U.S. Army Corp of Engineers in Seattle also saw great success using a similar approach in their recent project.³ What innovation can your team bring to your next project?

Case Study: University of Chicago Campus North Residence Hall and Dining Commons

The University of Chicago is located eight miles south of downtown Chicago in Hyde Park. The campus includes around 160 buildings representing 15 million square feet. One of the newest buildings will be the Campus North Residence Hall and Dining Commons (CNRHDC), an 800 bed, 390,000 ft² (36 232 m²) dormitory and dining hall that will open in Fall 2016. The building is notable as being the first on campus to have a contractual performance goal specified as a site EUI (kBtu/ft²-year) energy target.

There were many reasons that led to the decision to establish an energy target for the UChicago project. A study on the long-term planning for the campus’ historic quadrangle led to important concepts such as a focus on maintainability, comfort, and energy performance. The university’s climate and energy plan is focused on reducing campus greenhouse gases. One consideration for the plan is new construction, which is estimated to substantially increase the overall campus size during the next 30 years. Establishing energy targets for new construction helps mitigate the risk on energy use and greenhouse gas generation for the campus. Furthermore, UChicago students will call this building home and they are interested in more energy-efficient buildings on campus. These disparate items culminated in the university asking the question: “Why not set an energy target for the new residence hall?”

The energy target selection was a multiphase process that involved referencing the EPA Target Finder, existing UChicago campus buildings, peer universities’ building data, and developing a preliminary energy model for the project. Analyzing similar buildings on campus helped to establish our current baseline. Analyzing CBECS data through EPA Target Finder informed the university of current “best in class” dorms. For example, a site EUI of roughly 85 kBtu/ft²-year (965 MJ/m²-year) is needed to receive Energy Star certification. The university also partnered with the Energy Center of Wisconsin and local electric utility energy efficiency program (ComEd New Construction Service) to develop a preliminary energy model for the building to demonstrate what energy performance was realistically achievable.

After the energy target scoping study was performed, the energy target for the residence hall was set at a site EUI of 65 kBtu/ft²-year (738 MJ/m²-year). An additional wrinkle was added by allowing two parameters to alter the energy target. First, the target can increase or decrease linearly based on the number of occupants and also the size of the facility. This was done to allow the design team an increased allocation of energy use if they were more efficient with space planning. Second, if the design team chose to use on-site boilers instead of campus steam, or if the design included a geothermal system, the energy target would drop by 10 kBtu/ft²-year (114 MJ/m²-year).

With the energy target established, the university issued a request for qualifications to 22 architects and 10 contractors with instructions to assemble design-build teams. Four teams were selected to complete a schematic design and compete for final selection for the building design. One concern was that a hard energy target would stifle the architectural design, and result in four similar looking buildings. Fortunately, the competition resulted in four unique designs, all with modeled energy performance less than 55 kBtu/ft²-year (625 MJ/m²-year). From this process, the university selected one design-build team and is now in the final phase of design.

Reflections

This process has been an engaging endeavor for the University. The ability to cite one specific number required for energy performance proved powerful. For example, at one meeting, the electrical engineer

described various methods to control the hallway lighting while referencing the impact on the energy target. The client made a decision to go with the most efficient method, because they had an understanding of impact on the energy target and could weigh that against other factors involved in the decision process.

The performance target ideally results in an energy model that is more accurate compared to a traditional energy model developed for tax deductions or green building compliance. It represents the building as designed, updated to reflect actual equipment selection, and is followed up with a measured outcome. As a result, the building energy use and major end uses will be known. This will aid in identifying any drift in the expected performance and the root cause of the degradation.

In the end, though the design and construction represents a multi-year process, it pales in comparison to the amount of time the building will ultimately stand. The simple act of establishing a realistic but challenging energy target will result in a tremendous amount of energy and greenhouse gas savings for the university over the next 50 plus years.

Lessons Learned

- Occupant plug loads are a large component of energy use. It will be crucial to educate students and staff on this impact and help them understand actions they can take to reduce energy.
- Considerations need to be made on how to accommodate future renovations in a building that has a very specific energy use target.
- It is crucial for the owner to inform designers what diversity factors and schedules are to be used for the plug loads and lighting. Everyone will then be using the same assumptions. This can be adjusted at a later time if required as the design solidifies.
- The energy target should be repeatedly communicated to the design team. It is crucial for them to understand the importance especially as new subcontractors are brought on.

Case Study: NREL's Research Support Facility

The National Renewable Energy Laboratory (NREL) is a national laboratory of the U.S. Department of Energy (DOE). NREL has a long track record in research related to building energy efficiency, especially in low-energy whole building design and zero-energy buildings. NREL facilities has embraced NREL's mission creating world-class laboratories and support facilities that minimize energy use.

While NREL set energy goals for its projects, design teams often struggled with meeting the goals within a cost target. NREL was often left to prioritize programmatic versus energy features in order to meet budgets. The goal was to engage the design team and the contractor to achieve programmatic and energy goals without

exceeding fixed budgetary ceilings.

NREL had created several low-energy laboratory buildings, lessons learned from previous projects helped create a procurement and management strategy to achieve very low energy buildings without

increasing the construction budget.

The solution is to align all the people involved in a project around a common goal. It was estimated that 1,000 people had some level of decision-making impact on the delivery of the building. These people include the owner, architect, contractor and their trade subcontractors, a subset of the occupants, and the engineers. The key is to find a method to motivate the decision making process and align everyone to the same goals.

NREL chose to use a performance-based design-build strategy for the RSF project. NREL would engage a contractor who would be solely responsible of the design and delivery of the project and hold them accountable for achieving project goals, including energy. To start, NREL prepared a "Request for Proposal" document that captured all project aspects and expressed them as performance criteria with no prescriptive solutions.²

The heart of the proposal was a prioritized list of project goals. Through a facilitated process, the owner team (made up of individuals from across the organization) created the prioritized list which contained divisions of "Mission Critical" (items that must be



Dennis Schroeder / NREL

National Renewable Energy Laboratory Research Support Facility.

completed), “Desirable,” and “If Possible.” There were entries about building function, sustainability, safety, and energy to name a few. The RFP and the prioritized list represented the voice of the owner. It was agreed early on that this document would not conceptually change and that when questions arose, the RFP would be referenced. A NREL Project Manager would be responsible for implementing the RFP without change. It was key that the owner did not change the prioritization during the entire building delivery process.

A short-listed group of contractors competed and their conceptual designs were evaluated on the ability to achieve the prioritized list in order given a constraint of a fixed price. Conceptually, this was the wish list and selection would be made on who provided the most value. While the project did not start out to be a zero-energy building (ZEB), the successful bidder showed that they could deliver the project with the potential to be zero-energy within the budget ceiling. As seen in the sidebar, “Aligning Program Metrics With the Energy Goal,” the ZEB goal was quite far down the list.

To be successful, the contractor’s team relied heavily on strong communication and management skills to drive the process. At the proposal stage, the contractor engaged an energy modeler to help inform the conceptual design required by the proposal. This helped fold the energy features into the architecture and the function of the building—leveraging those costs. As the project progressed, the sub-contractors were critical to providing innovation around controlling costs. Repetition was a key element which factored into the design. The building was built around a standard module with precast insulated concrete panels including the windows. The efficiency around the thermal envelope, coupled with the daylighting enabled the use of radiant heating and cooling in the ceiling slab—and an innovative technique of placing the tubing provided a cost point that was achievable on the building’s budget.

The end result was a Phase I project (240,000 ft² [22 297 ft²]) that uses half the energy as a traditional building producing as much energy as it consumes, including the corporate data center located in the building

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at a cost of \$259/ft². This figure is in the lower third of commercial office buildings built in the region during this time period. Using a similar process, Phase 2 added 120,000 ft² (11 148 m²) cost less per square foot, and has a higher energy performance. A parking garage also used the same process, except the energy goal was expressed as energy per parking space, rather than normalized on area and building occupancy.

Lessons Learned

- In a traditional project, the owner often has to make decisions about the projects goals during the process. In this case, those decisions were made based on performance criteria before the design started. The successful bidder voluntarily achieved all items on the wish list; this indicates that they could have been longer and included more levels of energy efficiency. The benefit of this is that owners need not determine the energy goal; it is established by what the market can bear.
- The owner can successfully use voluntary incentives that are prizes, that is, not tied to a deliverable. If you

do everything in the RFP, you have “acceptable” performance; anything beyond that is “superior performance” and can be rewarded through a voluntary program.

- The owner, independently, needs to create a set of plug loads and plug load profiles that will govern the project. The owner needs a strategy to achieve these loads as well as lighting schedules. For NREL, the plug loads are higher at night than predicted, but lower in the daytime. Nighttime lighting loads were not accurately predicted.
- The contractor and owner need to constantly be reminded of the RFP requirements. Use this document as the ultimate reference without variation. As mentioned earlier, the owner cannot change her mind during the process.

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