Overcoming Barriers in Market Transformation Programs: Motivating MEP Engineers to Provide More Efficient Design

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ABSTRACT

Architects and engineers are hired professionals who provide guidance throughout the building design process. Typically, with low profit margins, these designers' fees are set as a percentage of building construction costs. Therefore, mechanical/electrical/plumbing (MEP) engineers, who are largely responsible for designing energy consuming systems, rarely have time to research efficient technologies, tend to be risk averse in their designs, and generally replicate older, proven designs. Ultimately the MEP engineers must approve and stand behind their designs. Even with monetary incentives from utility market transformation programs, MEP engineers are slow to change their established design templates because they lack the tools and training to produce efficient systems.

This paper reports on work by CLEAResult Consulting (implementer of energy efficiency programs) and Entergy Texas (program sponsor) in coordination with MEP engineering firms to develop strategies to motivate and equip engineers to produce energy-efficient designs. Strategies include: providing education on efficient technologies; design guidelines; and technical assistance that can be easily incorporated into boiler-plate design specifications. Aspects of these strategies are based on or exceed standards/guidelines from ASHRAE, the New Building's Institute, CEE, CHPS, and IESNA.

As designers become more comfortable with efficient design elements, they will lead their clients towards constructing higher performing buildings that use less energy and reduce climate impacts. MEP engineers are pivotal to the success of utility market transformation programs, they are not currently targeted by most programs, and the lessons learned from this work should produce benefits (greater efficiency and reduced climate impacts) for other market transformation programs.

Background

Entergy Texas offers a suite of energy efficiency programs to its customers and hires consultants as program implementers. The writers of this paper, Entergy Texas and CLEAResult Consulting, have worked to identify opportunities to improve program implementation and to develop strategies to overcome market barriers. This paper presents our strategies, lessons learned, and conclusions in motivating design engineers to provide more energy efficient building designs.

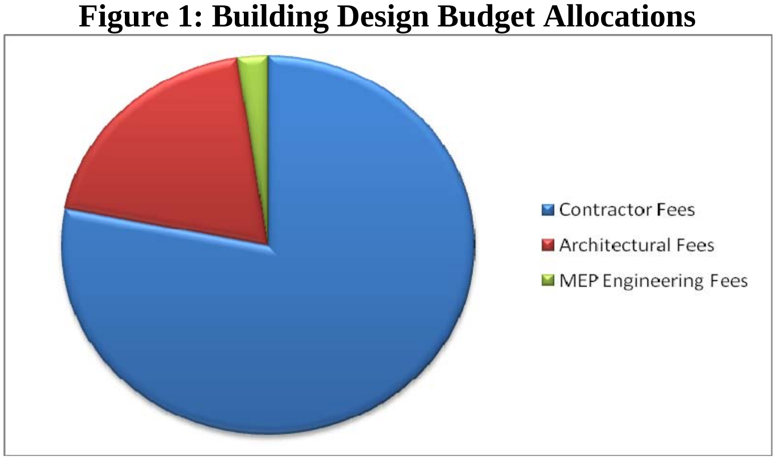
MEP Design Engineers and their Roles in Market Transformation Programs

In Texas, two main forms of energy efficiency programs exist: market transformation programs (MTPs) and standard offer programs (SOPs). According to the Public Utility Commission of Texas (PUCT), MTPs are Strategic programs intended to induce lasting structural or behavioral changes in the market that result in increased adoption of energy efficient technologies, services, and practices, as described in this section. SOPs are defined as programs under which a utility administers standard offer contracts between the utility and energy efficiency service providers (PUCT Substantive Rules). The advantages of market transformation programs include:

- MTPs are designed to address barriers beyond the first-cost of equipment. Energy efficiency studies typically cite a list of barriers including need for education, lack of awareness, need for training, inexperience, poor communication, and bureaucracy of organizations as well as first cost.
- SOPs can lead to cream-skimming (i.e., only capturing the lowest-hanging fruit) since standard payments are made for energy efficiency (kWh) and demand (kW) savings regardless of measure(s).
- Over time, SOPs can increase in cost because it often takes more monetary incentives to achieve the same amount of savings after participants have been "cream-skimming" the measures that pay back the fastest. MTPs are designed so that costs should stay the same or go down over time due to education, awareness, and other capacity-building activities that change market behavior and infuse energy efficiency thinking into the normal course of business.

For most commercial building construction of any significant size or complexity, a building owner entrusts the management of the design to an architect (even in design-build contracts, architects are relied on heavily). Since architects are most skilled in aesthetics and building functionality, they work with the owner to determine the scope of the project, and they hire a mechanical/electrical/plumbing (MEP) firm to design those building systems. Figure 1 below shows typical budget allocations for design fees as a percentage of construction costs, and these relatively small budgets leave MEP engineers with little time to do more than traditional designs. The low budget allocation for MEP engineers has a substantial impact on national energy use because MEP systems consume most of the energy in buildings and because residential and commercial buildings account for 39.9% of all energy use in the United States in 2009 (USDOE 2009). In fact, HVAC systems alone account for 40 – 60% of commercial building energy use (USDOE Commercial Buildings).

Figure 1: Building Design Budget Allocations



Despite the fact that MTPs address important market barriers, they do not always address the important role of design professionals, especially MEP engineers. MTPs tend to focus their efforts on educating, motivating and incentivizing the building owners, who have the authority to decide what equipment goes into energy-consuming systems. However, owners are generally unknowledgeable about MEP systems and are heavily influenced by MEP designers. We believe that, due to current low budget percentages for MEP designers and the traditional focus of MTPs on owners, MEP engineers are currently not adequately incentivized to incorporate newer, more efficient technologies in their designs. This paper will highlight the opportunity to make MTPs more effective by engaging design professionals directly.

Barriers to Energy Efficient Design

To address this fundamental challenge to effective MTP design, we analyzed the following barriers to energy-efficient design as they relate to MEP firms.

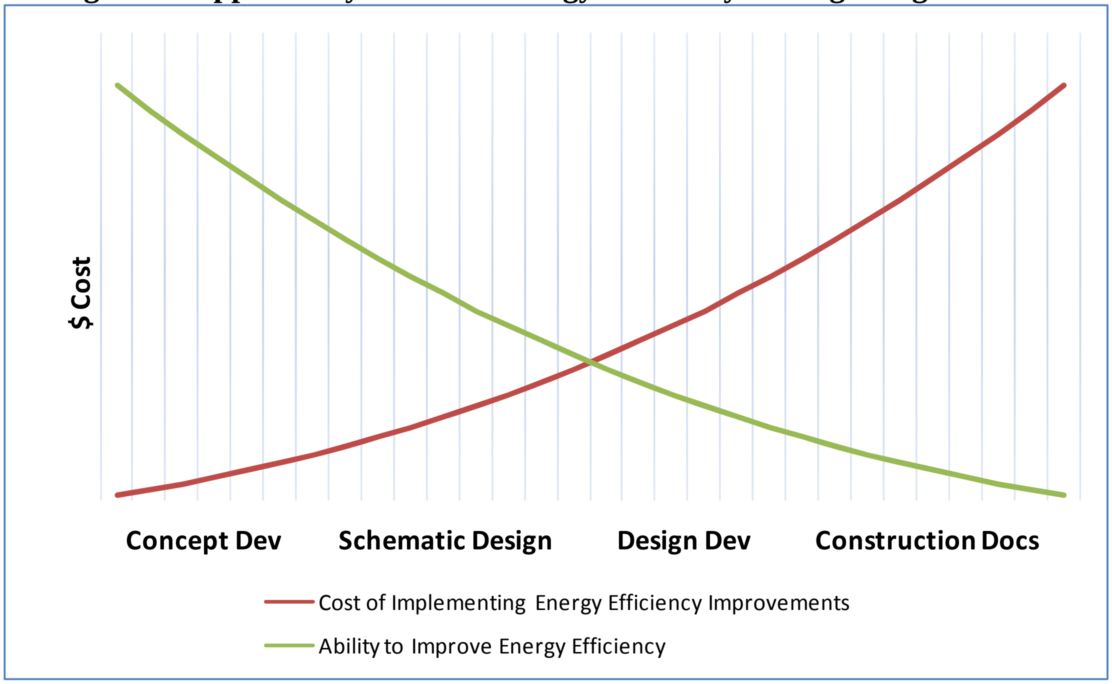
MEP Engineers Are Risk Averse

MEP engineers are generally risk averse when considering newer, more efficient technologies because small MEP budgets leave little time to analyze new technologies and any associated risks. MEP engineers tend to use design techniques and equipment selections that have proven to not cause problems for the owner and, therefore, the engineer. Small budgets prevent MEP engineers from researching new technologies and modeling the buildings for accurate load analysis. Often engineers modify previous designs, perpetuating the construction of lower performing buildings. MEP engineers cannot afford to provide redesigns or, even worse, incur penalties due to faulty designs. In other words, MEP engineers provide designs that avoid problems rather than those that are innovative and more efficient. Furthermore, Principle Engineers of MEP firms, some with decades of experience, guide their designs and those of more junior staff towards established and potentially less efficient design. For these reasons, MEP designs typically consist of industry standards driven by code rather than of innovation and a focus on energy efficiency.

MEP Engineers Are Left Out of Designs until Too Late

Waiting too late in the design process can create a perceived increase in design costs for energy efficient systems. As shown in Figure 2 below, the longer one waits to influence the energy efficiency of a design, the more costly it becomes. MEP engineers are often not included in the early stages of design, and they ultimately provide designs that rarely exceed code-required system efficiencies. Owners and architects generally work together to determine high-level HVAC equipment preferences (e.g., DX vs. hydronic systems), lighting systems, and plumbing fixtures while later communicating to the MEP engineer these system preferences. By this time, established high-level design parameters, crawlspace configuration, and chase and mechanical room sizes hinder MEP design options.

Figure 2: Opportunity to Affect Energy Efficiency During Design Process



Maintenance Cost Concerns

Often upgrades to energy efficient systems are perceived to require more maintenance throughout the life of the equipment. As manufacturers promote the newest technologies, designers and owners are reluctant to incur potentially higher maintenance costs from less established technologies. However, this resistance prevents the acceptance of readily available field tested energy efficient alternatives.

Lack of Available Contractors

Efficient technologies and systems in MEP designs are sometimes hurt by a lack of available contractors. Examples include: a potential lack of contractors able to drill geothermal wells for ground source heat pump systems; reliable water treatment system contractors for water cooled chillers; and contractors with a track record of installing and maintaining photovoltaic rooftop systems.

Concerns about Occupant Comfort

Designers are often concerned, for good reason, that newer HVAC equipment designs and higher efficiency light fixtures could compromise occupant comfort. A designer might not trust, for example, a CO_2 sensor or a motion sensor that could produce significant energy savings. Designs can also be driven by occupants' desires for individual HVAC control, which can compromise the energy efficiency of the system. For example, owners may request packaged DX systems rather than centralized chilled water systems in some buildings. Though individual DX units for each room would enable occupants to control their room temperature independently, the energy use is significantly higher when compared to a chilled water system.

Strategies to Overcome Market Barriers

MEP Engineers are Risk Averse

To address the risk aversion of MEP engineers, as part of our Texas MTPs we provide documentation and case studies on recommended technologies that are proven in the marketplace to be reliable and cost effective. We are careful to maintain our vendor neutrality. To help mitigate the risk that would be assumed by the MEP engineer for more innovative, energy-efficient equipment, our experienced engineers interview and document lessons learned from utility program participants, maintenance staff, and contractors who have implemented the newer technologies. Our program implementation engineers also attend industry conferences and pursue continuing education through certifications (e.g., CEM, CLEP) to ensure they are knowledgeable of widely-accepted methods of energy-efficient design.

We also present to the MEP engineers vendor-neutral educational materials on technologies and design standards to assist them during their equipment selection process. The educational materials address operational advantages as well as energy use/savings compared to standard alternatives. Examples include:

- Lighting systems that satisfy IESNA's guidelines for indoor lighting levels, exceed typical specifications for quality, and optimize performance with tuned ballast factors and high-output tri-phosphor lamps.
- HVAC efficiencies that satisfy the New Buildings Institute's Core Performance Guide for HVAC equipment, which have been proven to be cost effective.
- Roofing reflectance and insulation levels that exceed code are most appropriate for local climate and building type, but do not exceed cost-effective levels.

We have developed and provided MEP designers with case studies of program participants who use the recommended technologies and are willing to be contacted to provide feedback. We have found case studies to be particularly effective in motivating both program participants and MEP engineers to implement energy efficiency measures because *local* peers are compelling, having dealt with similar pressures.

For lighting designs—both new construction and retrofits—we suggest replacing existing lights in one or two rooms of an existing space with high performance, high efficiency alternatives. Most MEP designers are skeptical, at first, that modern high-lumen equipment with two lamps per fixture can improve the appearance of a space previously lit with three or four lamps per fixture. The test can often be done in-house or at no cost with a lighting contractor, and this enables the owner to buy into the design before proceeding with the new design.

All of the strategies described above reduce the risk incurred by the MEP engineers so they are more likely to consider energy-efficiency alternatives.

MEP Engineers Are Left Out of Designs until Too Late

To address this barrier we suggest to our program participants that they request that the MEP firm be involved early in the design process. To reinforce this, we have created design guidelines that can be referenced in the early stages of the design process (e.g., conceptual development and schematic design stages). We have referenced industry best practices and included standards from ASHRAE, IESNA, NBI's Advanced Building Core Performance Guide, CEE, and CHPS. The intent is to present a targeted compilation of the standards to use when the MEP engineer is most likely to consider alternatives. Also, we provide technical assistance that can be easily incorporated into boiler-plate design specifications.

Maintenance Cost Concerns

Our programs have been dedicated to recommending only energy efficient technologies and systems that will not penalize the owner with increased maintenance. With the experience of our engineering staff, knowledge gained from industry conferences and publications, and feedback from our program participants, we recommend only widely-accepted technologies and systems. For example, there is often a misunderstanding that more efficient instant-start electronic ballasts significantly reduce fluorescent lamp life and increase costs due to more frequent lamp replacements. We provide lamp-life specifications and calculations that show why advances in these ballasts make them a lower life-cycle cost alternative. Similarly, some facilities managers are concerned that more efficient HVAC systems will be more complex and incur higher maintenance costs, but there are many "paths" to higher efficiency, and often it is possible to specify equipment with higher efficiencies simply by ordering equipment with larger heat exchangers that contain more copper tubing.

Lack of Available Contractors

To address this barrier, we work to share information between local contractors, owners and the MEP engineers. We often find, for example, that owners and designers are not aware of how others in their area have overcome problems with support contractors, and the MTP is able to overcome this barrier simply by sharing success stories. If necessary, we will contact contractors within the area to determine if there is a necessary level of support, but we defer to the MEP engineer to make this determination.

Concerns about Occupant Comfort

Often, occupant comfort is considered to be at odds in the design with consideration of energy efficient alternatives. In reality, good energy-efficiency design can improve occupant comfort. There are many options to satisfy the requests of the occupants while conserving energy. In the example above of DX versus chilled water HVAC systems, proper controls such as demand-control ventilation, temperature reset, proper zoning, and VSDs enable the chilled water system to reward the owner with lower operating costs without compromising occupant comfort. Another example is properly specifying and commissioning occupancy sensors, which can save energy without compromising occupant comfort when dual-sensor technologies are properly specified and calibrated.

Motivating MEP Engineers, Case Studies

Participant: Owner, County Commissioners Court. Building Type: Office Building

In 2009 we worked with the County and their design team to include an efficient lighting system for their Commissioners Court office building. Unfortunately, the lighting design was close to complete (75%) and changes would have caused additional design costs. Nevertheless, we analyzed their current lighting design and determined that the building would most likely be well over lit and therefore use excess energy. For example, a 10.5 ft x 15 ft office (157 ft^2) was designed to have four 3-lamp T8 fluorescent fixtures (85Watts each), resulting in a 2.1 W/ ft^2 lighting power density. For an office space, ASHRAE 90.1-2007 allows no greater than 1.1 W/ft^2. Despite this, the design team denied our recommendation to perform a photometric analysis and to consider lighting design alternatives. Once construction was complete, we interviewed the owner (Director of Infrastructure), and the Director believed the building was over lit, including his own office. We revisited the site and measured 106 foot candles in his office, which contained eight 3-lamp T8 fixtures. Standards from IESNA recommend only an average of 30-50 footcandles for the office-general category. We disconnected two of the eight light fixtures in his office, and he was excited to see the removal of glare on his computer monitor screen. Later, he stated that he continued to keep the two fixtures disconnected, that his headaches subsided, and that a newly-hired energy manager also disconnected two fixtures in his own office.

Conclusion. We believe that the owner could have saved significant energy and produced significantly better lighting conditions had our recommendations been considered earlier in the design process. Performing photometric analysis and adjusting the design accordingly, even later in the design process, would have been a worthwhile investment for the minor increase in design fees. Nevertheless, this case study is an example of the challenge that MTPs face when attempting to influence designs late in the process.

Participant: Owner, School District. Building Type: School

In 2009 a school district requested our assistance for an 80-ton chiller retrofit, due to our vendor neutrality and because they received a seemingly exclusive bid from a contractor. Fortunately, we were involved early in the design process since the owner was working directly with the MEP firm to decide the most appropriate chiller selection (efficiency versus cost versus necessary equipment features). To assist the MEP engineer, we researched different chillers based on equipment requirements such as tonnage, refrigerant type, compressor type, and efficiency at a variety of conditions. Though higher full load efficiency at peak design conditions increased monetary incentives in our peak-kW-based programs, we communicated the importance to consider part load efficiencies at year-round conditions. We presented to the MEP engineer several options (good, better, and best efficiency) based on readily-available equipment and suggested to the owner that they solicit a re-bid with alternates to do an accurate cost/benefit analysis of the options. Ultimately, the owner purchased a chiller from the same manufacturer as the original bid, but the new chiller was significantly higher in efficiency and approximately $12,000 cheaper.

Conclusion. We believe that this is an example of the advantages of educating the design team early of readily available energy efficient equipment. Furthermore, the owner now understands the advantages of soliciting add-alternate bids to assess cost/benefits of design options.

Participant: Design Professional. Building Type: Office Building

In 2008 we developed a relationship with a large architectural firm while providing lighting recommendations for a school district. A principle architect at the firm, impressed with the lighting efficiency upgrades at the school district, included us in several of his client meetings to educate owners on energy efficiency opportunities. Furthermore, he redesigned his own office building and upgraded from fluorescent T12s to Super T8s (high-output, high-performance, tri-phosphor T8s). He understood that the energy savings quickly paid for the project costs, regardless of the utility program monetary incentives. The architectural firm is now a strong advocate of lighting efficiency, they use their office as a showroom, and they often include high efficiency lighting systems in their designs.

Conclusion. We believe that this is a clear example that design professionals, when convinced of the benefits of energy efficient building systems, can be some of the most effective motivators in transforming markets toward energy efficiency. As trusted design team leaders, MEP engineers and architects can effectively educate owners of the benefits of energy efficiency and appropriately influence owners to incorporate high performance building systems.

Conclusion

Representing both a utility program sponsor and a program implementer of market transformation programs, we have seen that the effectiveness of MTPs can be improved by addressing market barriers associated with building design teams, especially the MEP engineers. We believe building designers—as trusted design professionals—will be advocates of and effective motivators toward energy efficiency if they can be involved early in the design process and be educated on the specific advantages of low-risk improvements to the efficiency of building systems. We have identified barriers that hinder energy efficient design and implemented strategies that overcome those barriers with mixed results. But the improvements to these MTPs are not complete.

We will suggest new MTP elements that reward owners and architects when they include MEP engineers early in the design process. Furthermore, we will continue to develop new calculation tools, case studies, product comparisons, and financial models to educate the MEP engineers of low-risk equipment and design alternatives to increase the building efficiency. Finally, we will expand and refine tools for the owner to solicit add-alternates for different system efficiencies so that they can make educated decisions based on accurate cost/benefit analysis.

Members of the team writing this paper are also working in other states, running a variety of energy efficiency programs, and we will continue to research this topic and develop new tools so that market transformation programs are more effective at motivating the market toward energy efficiency.

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