The High Performance Solution: A New Approach to Commercial New Construction

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ABSTRACT

This paper will discuss a new approach to promoting energy efficiency and indoor environmental performance in new commercial buildings. The goal is increased marketplace knowledge and better practices aimed at designing and constructing high performance commercial buildings. Such buildings provide superior energy efficiency, systems performance, comfort and highly productive internal environments. Using a building sciences perspective to provide key technical information, this method addresses construction project management practices, building technologies and tools necessary to the successful construction and delivery of high performance buildings.

This approach is designed to be a cost-effective program solution for projects that do not warrant full-building energy simulation. Medium to large (20,000 to 80,000 square feet) in size, these buildings comprise the largest percentage of new non-residential construction projects. The core of the strategy relies on whole-building "technology" patterns (prescriptive approaches), which are pre-defined specifications based on recognized energy efficiency approaches. These patterns are applied to a building design during the schematic design stage of the project, generating a pre-determined expected energy savings.

This paper will provide an overview of the concept, connections that have been made to other efforts, including the US Green Building Council's Leadership in Energy and Environmental Design (LEED™), and current efforts to use this approach in utility commercial new construction programs. It will discuss the energy and economic benefits of using this approach from both the customer and utility perspective. This effort is the first step of developing new ways to deliver high performance buildings.

Introduction

In the early 1980's new construction and efficiency programs spread throughout California, and into Wisconsin, the Northwest and New England. These voluntary programs were the first attempt to directly influence the practice of design and construction of new commercial buildings. These programs focused on providing design team education, technical support and direct funding to influence individual building designs (Nadel 2000). The mid-1990's ushered in an era of reduced funding availability, and organizations refocused on programs that would result in the required kWh savings goals while simultaneously meeting wants and needs of owners and designers to encourage their participation without subsidization. In doing so, new programs focused on end-user benefits – daylighting, indoor environmental quality, sustainable construction practices and reduced operating and maintenance costs. Additionally, these programs had a goal of long-term change in practice that would exist beyond a specific project. They also assist in changing the process of designing a building as well as educating design teams on new technologies (Johnson 2004). But new program designs still miss some specific opportunities to work with the market to deliver better buildings.

Gaps in Current New Construction Programs

There are a number of gaps that exist in current new construction programs. These include:

- Low market penetration in small- to medium-sized buildings (Eijadi, Johnson, McAteer 2003),
- Need for alternatives to computer modeling as the main tool for integrated or whole-building design (Peters 2001),
- Incentives currently target technology procurement rather than the design process,
- Lack of cohesive integration between education and technical assistance programs (Johnson, Jan 2004),
- Focus on building design versus installed building performance (Johnson 2003), and
- No clear link to national brands such as LEED or ENERGY STAR (McAteer 2003).

Filling the Gaps

The Advanced Buildings program was developed to fill the gaps in existing programs and leverage the successful efforts of utility and pubic benefit programs.

Market Penetration

The Advanced Buildings program targets facilities that range in size from 20,000 to 80,000 square feet and comprise 46% of commercial building square footage (Census 2000). These facilities usually have a full design team (or design-build contractor with in-house design professionals) and owners who can be motivated to step outside the box of conventional practices. In particular, regional health care facilities, K-12 schools, grocery stores and some public facilities could benefit from building a high performance building.

This is historically a difficult-to-reach market because of poor benefit-to-cost ratios for providing detailed technical assistance. Advanced Buildings provides assistance through tools and trainings and reduces the need for one-on-one technical support in most programs.

Alternative to Computer Modeling

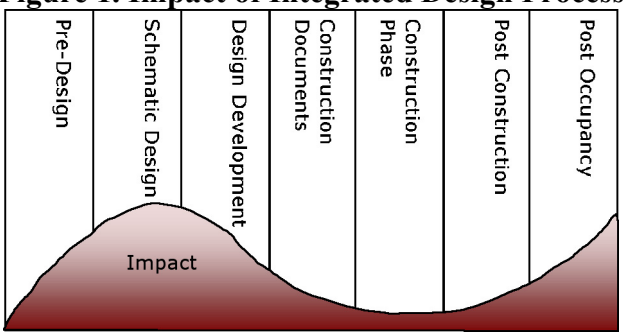
The prescriptive criteria contained in the Advanced Buildings *Benchmark* help reduce design costs and increase design efficiency. These nationally accepted criteria provide designers with a ready-made pattern for whole building design. Using these patterns, whole-building design approaches can be implemented without detailed modeling. This reduces the overall need and "hassle" cost associated with typical program design (Peters 2001).

"Schematics to Occupancy" Design Process

Current programs often focus on providing financial incentive for specific technologies. While this can provide piecemeal savings, the cost of opportunities lost due to an inability to address integrated whole building performance can be great. Advanced Buildings incorporates a system that promotes early design intervention and reduces the cost of lost opportunity.

The integrated design process promoted by Advanced Buildings can be used by design teams to produce high performance buildings for a 0% to 3% cost increase over an average building (Johnson 2003). Figure 1 shows how early efforts to focus on building performance can have the largest impacts.

Figure 1. Impact of Integrated Design Process



Integrate Educational Component

Technical education and training have been proven effective in increasing adoption of efficient design strategies, but only if delivered following a proven method of adult learning. Advanced Buildings builds off of the curriculum development methodology of the Energy Center. Technical curriculum developed by the Energy Center for the Daylighting Collaborative incorporates a combination of technical training and follow-up technical assistance. Seventy-seven percent of the Collaborative's educational program participants applied their training to the next project (Bensch 2001). Another example of the strong relation between focused technical training and energy savings is the Compressed Air Challenge training. This program yielded a cost-benefit ratio of $82 in energy savings for each training dollar spent (LBNL 2004). Technical training is closely linked to the Advanced Buildings resources to leverage marketing, training and technical assistance efforts.

Focus on Performance

Energy efficiency program managers are primarily responsible for setting targets for new designs. 68% of program managers surveyed (Johnson 2003) indicated they set energy targets during the design phase. Advanced Buildings includes explicit process steps that begin in pre-design and extend beyond building to assure design performance is delivered to the building owner.

Link to National Brands

Most new construction programs create a unique approach to the market for their region or service territory. As emerging national brands play a larger role in regional and local markets, programs need to complement and leverage these brands, specifically LEED and ENERGY STAR. Advanced Buildings allows the incorporation of these programs rather than creating another competing brand in the marketplace. By showing how to achieve the energy efficiency and performance necessary to participate in these programs, Advanced Buildings integrates multiple efforts into a single program offering.

National Benchmark for New Building Performance

The *Benchmark* was developed following a set of requirements largely based on the ANSI Procedures for the Development and Coordination of American National Standards. In accordance with those requirements, a national Criteria Review Committee consisting of a balance of code officials, utility new construction program staff and interested and affected parties representing the design, construction, real estate and manufacturing communities reviewed, voted on and approved the Benchmark.

What Is Different about Advanced Buildings?

Advanced Buildings is a next generation new construction program model that focuses on energy efficiency and indoor environmental quality in a difficult-to-reach market – mid-market buildings typically ranging from 20,000-80,000 square feet. Under most current programs, these buildings usually do not warrant full building simulation and yet have more savings potential than can be realized if routed through individual measure programs. The key difference of Advanced Buildings is the hybrid concept of providing prescriptive whole building design patterns for this middle market. Typical programs either provide prescriptive rebates for individual measures for small projects or incentives/assistance based on whole building performance for large projects. Advanced Buildings focuses on showing designers how to deliver high performance for whole buildings by providing quantitative and descriptive specifications for system and component performance and design. The design team now has access to whole building patterns and design strategies that can be utilized to generate predetermined expected energy savings.

Using a building sciences approach to provide key technical information, this strategy addresses construction project management practices, building technologies and tools necessary to the successful construction and delivery of high performance buildings. The technical and educational elements of Advanced Buildings focus on meeting the dual goals of achieving measurable energy savings and initiating long-term changes in practice. The approach provides:

- Whole building design patterns to achieve energy, atmosphere and indoor environmental performance,
- Learner objective-based educational tools to teach designers how to sell and apply Advanced Buildings to their projects,
- Links to US Green Building Council's LEED program,
- Support of utility and public benefit programs that promote energy efficient new construction, and
- Building performance component that emphasizes delivered performance using the US Environmental Protection Agency's ENERGY STAR Rating Tool.

Advanced Buildings addresses gaps in resources available to the owner and design community by providing the following tools and resources:

- **Advanced Buildings *Benchmark* (what to accomplish) –** Developed through an ANSI-like process and provides energy performance targets and recommended design specifications for:

- Lighting Systems
- Building Envelope
- Mechanical Systems
- Building Control Systems
- Demand-responsive Buildings
- Renewable Energy Systems
- Other Electrical Equipment

- **Advanced Buildings Reference Guide (how to accomplish it) –** Provides technical information to design teams to assist in application of the performance goals and specifications contained in the *Benchmark*. It covers building envelope, heating, ventilating and air conditioning systems, lighting and power systems.
- **Advanced Buildings Owners Guide (why it should be accomplished) --** Provides resources for designers to sell the concept to owners/developers, provides an independent reference for owners/developers, and encourages owners and decision-makers to make an early commitment to energy efficiency. It also provides information on the estimated cost of designing to the *Benchmark* criteria and illustrates the investment's cost effectiveness.
- **Advanced Buildings Education and Training (how to accomplish it on your next project) --** Using a building sciences approach to provide key technical information, the technical trainings address construction project management practices, building technologies and tools necessary to the successful construction and delivery of high performance buildings, all of which participants can utilize on their very next project. The training design is based on proven adult learning methodologies.

Energy Savings and Other Economic Benefits

A cost and savings study was performed (Edelson 2003) in conjunction with development of the Advanced Buildings *Benchmark*. The purpose of the study was to develop a first estimate of the energy and financial impacts of implementing the patterns and measures outlined in the *Benchmark*. Meeting all of the basic criteria and all of the prescriptive criteria completes the prescriptive path to compliance with *Benchmark* and the Reference Guide, potentially avoiding the necessity for a building simulation.

This study design was not intended to estimate potential national savings of *Benchmark* over ASHRAE 90.1, but rather to illustrate a range of potential efficiency improvements and the costs and savings associated with those improvements.

The office prototype using the proposed *Benchmark* measures consumed 29-31% less electricity (depending on climate zone) than the same prototype in ASHRAE/IESNA 90.1-1999 compliance. The *Benchmark* measures also reduced gas consumption by 10-31% more than ASHRAE/IESNA 90.1-1999. Table 5 shows the range of impacts on the office prototype.

Certain productivity and health benefits accrue from the provision of improved ventilation in work and study spaces. Specific "acceptance" requirements in *Benchmark* require the design team or contrator to verify outdoor air ventilation rates prior to building occupancy.

Table 1. Office Prototype Impacts

Result	Low	High
Construction Cost Premium (USD/sq.ft.)	$0.69/sf	$1.15/sf
Energy Cost Savings (USD/sq.ft./yr)	$0.22/sf/yr	$0.61/sf/yr
Simple Payback	1.2 years	4.8 years
kWh per square foot savings	3.6 kWh/sf	4.1 kWh/sf
Total Energy Savings beyond ASHRAE 90.1	11%	24%
Savings using ASHRAE Energy Cost Budget	35%	39%
LEED Credits	11 credits	13 credits
Value of Improved Ventilation	$1,1679,000	$2,251,000

Advanced Building New Construction Program Design

As a next generation program, Advanced Buildings is completely end-user oriented, but designed for implementation by efficiency programs by:

- Targeting specific building sector size, type, and usage profiles that are either underserved or hard to reach
- Providing the what, why and how
- Creating an integrated message to the market by collaborating with national (LEED and ENERGY STAR), regional, state, local and utility efforts.

Currently, new construction programs are either focused on a "low path" (prescriptive rebates, low levels of direct intervention), or a "high path" (custom rebates, high levels of design or technical assistance). Advanced Buildings is designed to provide a "middle path". The middle-path approach combines four key elements:

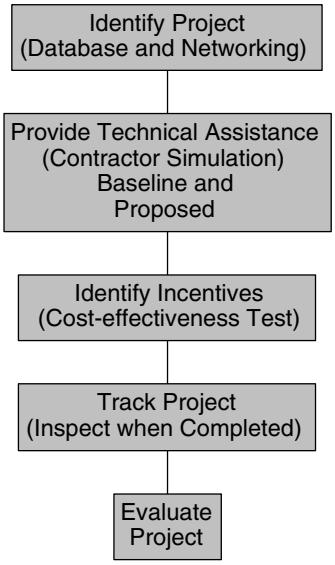
- Education and training to promote marketing of the program, early design intervention and translate technical knowledge to the design community,
- Patterns (based on Advanced Buildings *Benchmark*) to establish envelope, mechanical and lighting performance thresholds,
- Design and construction process that delivers robust performance, and
- Incentives (including technical assistance, design team funding and owner incentives) that complement the approach.

This approach has some implications for new construction program design. They include:

- Early design intervention,
- Education and training, and
- Design assistance and marketing.

The structure of most existing programs is shown in Figure 2:

Figure 2. Traditional New Construction Program Design



The program design shown in Figure 2 has evolved over the past 20 years to effectively deliver reliable energy savings to specific new construction sectors. Advantages of this design are reliable cost-effectiveness tests and ease of managing the program with a small staff. Disadvantages are the high administrative costs inherent in smaller projects and an inability to develop a mass market for the program. Typically, program staff is working with an existing design to measure improvements against a baseline and trying to make incremental efficiency improvements. The absence of early project influence and an industry-accepted set of best design practices leaves a large gap in maximum energy savings.

The program design structure for the Advanced Building approach is shown in Figure 3. This program builds off of the traditional program path in two areas:

1. Promotes the program to the A/E community as a key marketing strategy and a way to build technical assistance into the marketplace, and
2. Increases the value of the marketing and design assistance efforts by a more comprehensive design process approach that is closely aligned with market transformation goals while still producing measurable energy savings.

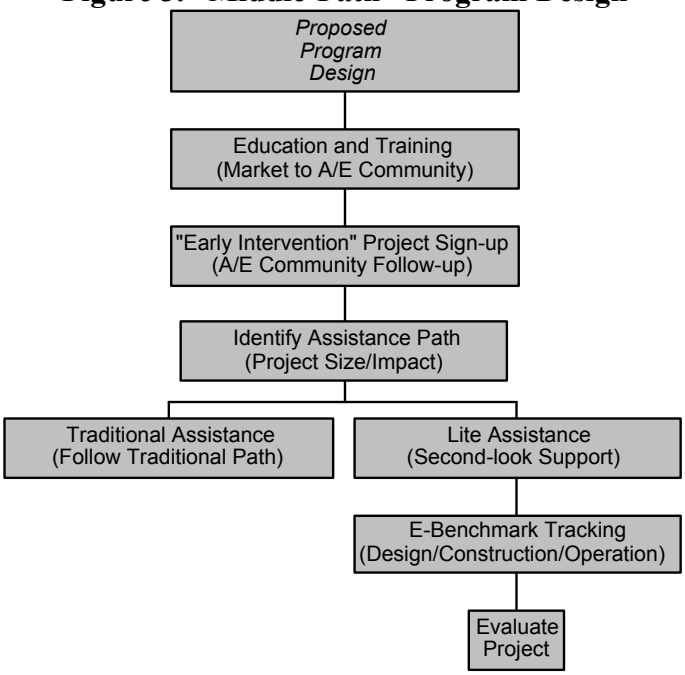
This program path also provides design incentives in addition to traditional building incentives. The design incentives are necessary to promote "early design intervention".

The key elements of this middle-path program design are:

- Redistribution of utility administrative and incentive dollars to promote the program within the architectural and engineering (A/E) community,
- Increased market penetration through improved cost-effectiveness to provide design assistance to smaller projects,
- Increased overall program cost-effectiveness through improved building performance (acceptance testing), early-design intervention, and A/E partner co-marketing,
- Adoption of a set of design recommendations by the market in advance of project activity, and

- Industry established set of best practice design recommendations applicable to a wide range of small building types.

Figure 3. "Middle-Path" Program Design



An example of how this approach works is shown in Table 2.

Integration with Existing Programs

Utility Programs

Advanced Buildings is designed to either complement existing programs, helping to fill gaps or reach difficult markets, or serve as the new construction program as a whole.

Three Wisconsin utilities are incorporating Advanced Buildings into their new construction efforts: Alliant Energy, WE Energies, and Madison Gas & Electric. In addition, Advanced Buildings is the umbrella program for the entire WE Energies new construction program, including training, products and incentives. Additionally, Efficiency Vermont has released its 2004 Commercial New Construction Program, and *Benchmark* has been chosen as the efficiency tool for that program.

As all of the above programs are in the early stages, evaluation results are not yet available.

National Efforts – LEED and ENERGY STAR

LEED, ENERGY STAR and Advanced Buildings have a common goal of improving the performance of buildings to create multiple benefits to the owner, occupants and environment. All use targets and guidelines as a primary tool to work with the marketplace in effecting these

changes. The Advanced Building's *Benchmark* criteria were designed to be compatible with and support LEED, ENERGY STAR and other sustainable or green building programs. Advanced Buildings assists the design team in achieving the energy performance targets outlined in various programs.

Table 2. Program Process Steps

Program Process Step	Action	Incentive
Education	Design team attends educational events to learn how to sell and apply Advanced Buildings to their projects.	AIA Credits, increased design firm fees, and form partnership with program administrator.
Pre-design	Design team presents Advanced Building option to client and registers project on web site. Operational Performance Requirements (OPR) developed.	Increased design fee from building owner and potential design incentive from program administrator.
Schematic Design	Translate OPR into design through pre-defined patterns identified in Advanced Buildings.	Identify potential owner incentives.
Design Development	Product specifications reviewed to match patterns. Commissioning plan developed. Design processes acted upon (sizing, simulation, renderings, etc.)	Projects that enter program at design development phase or later are not eligible for design team incentives.
Construction Documents	Documentation submitted to program administrator for middle-path approval.	Costs and benefits defined for owner and incentive level agreed upon (pending final inspection and review).
Construction Administration	Bid submittals reviewed for "or equal" from an energy performance perspective. Acceptance testing performed and commissioning report prepared. Inspection to verify measure installation and review of commissioning report.	Projects not proving construction process oversight are disqualified from receiving design incentive.
Post-construction	Operational performance certified and final warranty review/completion verified.	Final payment released to design team and owner.
Post-occupancy	Benchmark building using ENERGY STAR performance rating tool.	Achieve a 75 or higher to achieve an ENERGY STAR building.

Table 3 shows how LEED credits may be assessed when meeting individual criteria containned in the Benchmark. This example is based on the prototype models described above and assumes that the *Benchmark* Basic and Prescriptive Criteria are fully met.

The *Benchmark* could only provide the following LEED credits if used in conjunction with approved USGBC documentation procedures.

Advanced Buildings requires that the design team establish a goal of 75 or higher on the ENERGY STAR Energy Performance Rating Scale. The Energy Performance Rating Scale defines the lowest energy performing buildings (most energy use per unit metric) as 1 and the highest energy performing buildings as 100. This requirement helps assure buildings are not only energy efficient but perform as low-energy buildings.

Table 3.Comparison of LEED Credits with the *Benchmark*

●	LEED Credit Fully Addressed by the *Benchmark*
◑	LEED Credit Partially Addressed by the *Benchmark*

LEED Credit ID	LEED Credit	Description	Credit Addressed
		Sustainable Sites	
Ssc72	Credit 7.2	Landscape & Exterior Design to Reduce Heat Islands (roof surfaces)	●
Ssc80	Credit 8	Light Pollution Reduction[1]	◑
		Water Efficiency	
		Energy and Atmosphere	
EAp10	Prereq 1	Fundamental Building Systems Commissioning	●
EAp20	Prereq 2	Minimum Energy Performance	●
EAc1	Credit 1.1	Optimize Energy Performance (20% to 50%)	●
EAc30	Credit 3	Best Practice Commissioning	●
EAc50	Credit 5	Measurement and Verification	●
ID 1.1	Credit 1.1	Innovation in Design	●
		Materials and Resources	
		Environmental Quality	
EQp10	Prereq 1	Minimum IAQ Performance	●
EQc10	Credit 1	Carbon Dioxide (CO2) Monitoring	●
EQc31	Credit 3.1	Construction IAQ Management Plan, Prior	●
EQc32	Credit 3.2	Construction IAQ Management Plan, During[2]	◑
EQc71	Credit 7.1	Thermal Comfort, ASHRAE 55-1992[3]	◑
EQc72	Credit 7.2	Thermal Comfort, Permanent Monitoring System	●

Source – Paladino and Company

Conclusion

Advanced Buildings seeks to create a permanent change in practice and achieve measurable savings in new construction by providing the what/how/why, creating an integrated message regarding the role of green and efficiency programs and focusing on the end-user.

By focusing on specific design patterns, a set of measures that interlink with LEED credits and ENERGY STAR can be used in many kinds of programs and by various interests in the commercial building market to achieve actual savings over base code and to establish a basis for high performance buildings. The prescribed measures also provide an alternative to developing an energy model for each qualifying building.

Advanced Buildings provides a tool to expand the market penetration of high performance commercial buildings in a key hard-to-reach market sector. As the application of accepted high performance building techniques becomes more widespread, costs will drop further, and demand from all sectors will increase. With the wide availability of tools like Advanced Buildings, branding efforts of ENERGY STAR and rating systems like LEED, the market transformation of the commercial building industry will be accelerated.

[1] Credit is met if LEED light trespass requirements are included in the design.
[2] Credit is met if LEED required filter change is done after construction and prior to occupancy.
[3] Credit is met if ASHRAE 55-1992 is specified as the basis for design.

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