Building Design For A Sustainable Future

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ABSTRACT

While potential for energy efficiency improvements exists in all sectors, one of the best opportunities to improve energy efficiency is to design it in from the outset in new buildings. The result can be a more cost effective, more comfortable, and more environmentally friendly building, often at little or no incremental cost. One such example is Canada's first C2000 office building, The Green on the Grand, which beat the ASHRAE 90.1 energy target by 50% with almost no premium in construction costs. C2000 is an experimental commercial building standard developed by Natural Resources Canada which targets maximum energy savings as well as the development of additional sustainability features such as reduced use of toxic building materials, reduce construction waste, recycled materials, etc.

However, energy efficiency is too often an afterthought in building design and usually left to the mechanical team. Yet, by the time a new project's design is passed on to the mechanical engineers, the design is often too far along in the process for them to make a difference without pushing costs up.

Conventional DSM Programs, offering incentives for higher efficiency equipment, were developed all over North America and resulted in savings averaging some 10% better than code. Few, however, resulted in the step change required to alter the design process and transform the market. This paper looks at the traditional approach to DSM in the new construction market, and outlines an alternative approach underway by Union Gas.

Introduction

Early DSM programs lumped new construction in with retrofit, renovation, remodeling and equipment replacement. As utilities got more sophisticated, new construction programs were separated from the retrofit programs. In the case of Boston Edison, for example, segmentation was done based on targeting time dependent decision processes versus discretionary decision process.

If higher efficiency equipment could be retrofitted onto a completed design, e.g. occupancy sensors, window film, light for light equipment replacements, utilities often counted such savings as if they had been designed at the outset. However, a fully integrated, energy efficient, design can achieve more savings that equipment add-ons or replacements, particularly when interactive or synergistic impacts are factored in to the savings.

New construction programs mostly focused on paying for higher efficiency equipment. In many cases the program used the local building code as a baseline, but programs designed to move standard practice by a given percentage were not common. When they were, it was for a modest amount. Table 1 illustrates some of the programs which referenced local building codes.

Table 1. Utility Programs and Local Building Codes

Utility Program	Exceed Building Code By:
BC Hydro	15%
Bonneville Power Authority	10%
City of Austin, Texas	15%
Consumers Gas	15%
NR Can (C2000)	50%
Northeast Utilities	Any Amount, bonus over 20%
Ontario Hydro	Any Amount
Pacificorp	Any Amount
Pacific Gas & Electric	10%
Portland General Electric	10%
Sacramento MUD	Any Amount
San Diego Gas & Electric	Any Amount; 15% for lighting
United Illuminating	Any Amount, bonus over 20%

A recent review of North American DSM Programs[1] presented the following findings:

- Influencing new construction and renovation requires careful attention to timing.
- Institutional market barriers plague program participation.
- Success is dependent upon the co-operation of many players.
- Addressing the fragmentation of the design process is a key to program success.
- Contacting designers early in the process is important.
- For architects, efficiency is less important than occupant comfort and satisfaction.
- Speed is of the essence so as not to affect tight budgets and schedules for contractors.
- External market conditions can play havoc with new construction programs.
- Working with trade allies is a key means of supporting the program goals.
- Differences in motivation and context exists between utility and government programs.
- For some utilities, proactive efforts in new construction required new skills and approaches to deal with issues not related to specific customer service.
- The standard level of free ridership was deemed to be 18 to 24% for equipment incentives. It appears that this figure became a fixture in US utility program evaluations.
- The free rider rate varied when individual prescriptive incentives were analyzed: from 10% for Motors and VSDs to over 60% for some kinds of lighting.
- The issue of an appropriate "base case" remains unresolved. The most usual method is to use the existing code. However, the degree of compliance to building codes ranges dramatically from jurisdiction to jurisdiction and even from builder to builder. Assuming that all building are built to code will understate savings where standard practice is below code. Ignoring that some buildings exceed code overstates the savings.

[1] Completed by Fraser & Company

Program Elements.

- The focus of most utility programs was equipment rebates or other financial incentives.
- Technical support, often in the form of design assistance for new construction program, up to and including providing building energy simulation free of charge was also key to participation.
- Often design assistance was provided by third parties on contract to the utility.
- Using case studies to remove the barrier of technical skepticism was common. Often, it is important to use segment specific case studies to show how a generic applications such as compact fluorescent lighting can be applied in specific building types.
- Workshops, training and seminars were often used, including building energy simulation for consulting engineers and architects.
- Design facilitation has been featured in Canadian and British programs but only in one of the surveyed US programs.
- The most common energy analyses programs were: DOE2, ASEAM, TRACE.

Marketing.

- Personal contact was critical and had to occur early in the design phase in order to affect the building design.
- Getting to architects is very important as they may be the only group involved in the project from start to finish. Even a developer may sell before completion.
- Direct mail and broad based advertising was not seen to be successful.
- Utilities made direct use of their existing relationships with customers, architects and engineers. Those who did not have strong relationships had to develop them.
- Membership in trade associations and related events such as trade shows was important.
- Often teasers or information pamphlets were delivered on a broad scale which included a call to action such as calling a 1-800 number, contacting the utility sales office or faxing for more information which were followed up with details on programs/rebates.
- "Saving money" was viewed as a stronger marketing message than "saving energy".
- Environmental marketing messages get a stronger play in Canada than in the United States; and a stronger play from governments than utilities.
- Use of award and recognition programs is important to break down broad based barriers.
- Most recent innovation is web sites, including capability to calculate incentives on-line.

Incentives.

- Most of the utility programs used incentives for specific equipment or for calculated energy savings rather than as a design incentive.
- Where design incentives were used, they were mostly in addition to equipment incentives.
- Penetration of design only incentives was not significant and often utilities quickly opted for equipment incentives. This, however, was most likely due to regulatory pressure for results. Affecting the design process from its outset can take up to four years to deliver results. Equipment incentives can "catch" a project just before equipment is installed but the impact may not be as great in yielding savings or affecting market behavior of design professionals.

- In many cases, the design incentive was used to penetrate the design process at an early stage so that the higher efficiency equipment could be sold to the project easier than after the design was completed.

Equipment Incentives.

- Most often incentives were between 50 and 100% of incremental equipment costs.
- Utilities used a cap equivalent to their avoided costs for incentive payments, sometime on an equipment by equipment basis and sometimes on a project basis.

Basis for Incentives.

- Design Incentives: Usual basis was paying full incremental design cost: between 5 and 10% or total design cost. Some programs paid a percentage of equipment incentives to the design team.
- Equipment Incentives: Utility avoided costs were a cap for incremental cost of equipment; incentives usually paid between ½ and all of the incremental costs. Few programs paid on the basis of energy or demand saved or on the basis of square footage. Ontario Hydro was a notable exception.
- Commissioning Incentives: Rarely included, but usually covered full costs or provided the service directly.

Eligibility.

- All customers of the utilities were eligible.
- Often the same program was used for all sectors.
- Sometimes the same program covered new construction, retrofit, equipment replacement, remodeling, renovation and add-ins with no differentiation of costs or benefits in the incentives or equipment.
- Often programs differentiated between large and small projects and/or prescriptive versus performance based incentives.

Approval Process.

- Approval to participate was included in some programs which provided an early warning to program managers on estimated future participation. This assisted in improved forecasting as well as serving to get decision makers aware from the outset of the program.
- Pre-approval was often required prior to design, or, in the case of equipment incentives, the acquisition of equipment. Often certifications by architects and/or engineers and appropriate stamps were required.
- Only one surveyed program guaranteed to maintain incentives at original promised level.
- The range of information required at the pre-approval stage ranged from definition of design intent to building simulations including input and output data in electronic form.
- Some programs used phases typical to a new construction project, others were more attuned to utility processing needs.
- Some utilities became intimately involved with design process, including sharing planning and execution roles with respect to energy analysis.

Verification.

- Verification included: comparative energy simulations commissioning, energy savings estimates by third parties, on site inspections during and/or after construction, equipment invoices,
- The most prevalent form of verification was post construction inspection to check installation (not operation) of equipment.
- Utilities have recently begun to tie customer retention to incentive payments, requiring, that any customers who opt for alternative suppliers repay a pro-rated amount of the incentive.
- Utilities often reserved the right to install metering equipment and to require the participant to participate in program evaluation.

Lessons Learned.

- High potential exits to impede design and construction with red tape, bureaucracy and delayed approvals.
- Impact on new construction is more effective the earlier it happens in the design process. Issues such as building orientation and shape can affect energy use but cannot be affected later in the design process.
- Many utilities subscribed to the Dodge Reports but had differing views as to whether the reports are timely enough to affect new designs.
- Free drivers are common in new construction: i.e., building designers who learned of conservation options from a program but did not install them in their current project, may give them additional consideration and include them in future projects.
- Design incentives need to address the fact that the traditional, sequential design process must be altered to reflect the value of multi-disciplinarily synergies.
- Measure installation should be verified by a third party.
- Savings estimates should be updated when measure installation is verified.
- Projects involving renovations should be excluded.
- Hard to verify measures like controls should be subject to conservative savings estimates.
- Decision maker information should be collected with the program application.
- Program goals must be clearly defined.
- Upper limits for the incentives must be in place;
- Sufficient staff resources must be available to service the needs of the customers in a timely fashion
- Rapid turnaround of the approval process is necessary.

Achieving High Participation Rates[2]

In 1994, the American Council for an Energy Efficient Economy released a study of DSM programs that achieved high participation rates. The following summarizes its findings with respect to new construction programs:

- Typically, new construction programs have two tracks: prescriptive track paying rebates for specific equipment or performance track which provides design assistance and custom rebates for a comprehensive package of optimized efficiency measures.
- Only a few programs achieved participation rates in excess of 50%: United Illuminating, BC Hydro, Pacificorp, and then only after three years.
- Successful marketing includes multilevel personal contact with design professionals and building developers, workshops and recognition programs.
- Paying full incremental cost for measures achieves greater savings. Both PG&E and Boston Edison achieved comparable penetration (35%) but the former capped its incentives at 50% of incremental cost and the latter paid full incremental cost and achieved twice the energy savings.
- Savings from commercial new construction programs have rarely been empirically evaluated. Engineering estimates indicate that savings are in the range of 10% over the prevailing design and construction practices.

Union Gas' New Commercial Construction Program

While the electricity sector in Ontario and elsewhere is in the throes of debate about competition, Ontario's gas market is one of the most deregulated gas markets in North America. In fact, over 70 per cent of the gas consumed in Ontario is not sold by the distribution utilities, merely transported.

The Ontario Energy Board continues to regulate Ontario's two gas distribution utilities and has required each gas utility to pursue demand side management since 1994. The reason for this requirement, from the OEB's point of view, is to achieve the environmental benefits related to energy conservation.

Even before the OEB required Union Gas and Consumers Gas to offer discrete energy conservation programs, each had included energy efficiency programs as part of the overall service to existing customers. These programs and services, however, did not penetrate very early in the design process for commercial buildings.

Union Gas customer representatives might have gotten involved in equipment specification stages, but more than likely their involvement was linked to new customer connections. Therefore, when the OEB required formal DSM planning and fuller coverage of all sectors, its DSM planners looked at the experience of other utilities.

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[2] Nadel, Steve, et al 1994, "Achieving High Participation Rates." *In Proceedings of the ACEEE 1994 Summer Study on Energy Efficiency in Buildings*, Washington, D.C.: American Council for an Energy Efficiency Economy.,

Traditional utility DSM programs used financial incentives or offered design services in competition with the existing design firms. Union Gas was not interested in competing in areas where they had no natural expertise or competitive advantage. What has been shown in the Canadian federal government's C2000 Program for Advanced Commercial Buildings. and in BC Hydro's PowerSmart program was that design facilitation that brings all the design professionals together and uses a team approach at the conceptual phase can result in innovation with little or no incremental cost.

Union Gas also believed that, as they become more involved in the building design process, they should add value to the process, not distort it. Their overall philosophy was one of "user pay" rather than broad based incentives, although it was prepared to use incentives if necessary.

One of its first initiatives was to support the promotion of Canada's first C2000 project, *The Green on the Grand* which beat ASHRAE's 90.1 standard by 58% yet added only $8,700 to the total cost of $1.6 million. Designed by EnerModal Engineering and constructed by Ian Cook Construction, the 23,000 square foot building includes a number of innovative HVAC features. It has neither a cooling tower nor a closed loop system for hot water circulation. Instead a man made pond in front of the building is an integral component of a heating and cooling system anchored by a combination 300,000 Btu gas fired boilers and a 30 ton, direct fired absorption chiller. The packaged unit uses water as a refrigeration with lithium bromide as an absorbent. The boiler has an efficiency rating of 85% and the chiller's co-efficient of performance is 0.95. Water used to heat the building is circulated from the pond into the boiler. The chiller's condenser loop piping also passes through the pond which acts as a heat exchange medium. During the cooling season, heat loss is enhanced by trickling the pond water over a series of landscaping rocks, increasing the effective heat transfer surface area. Supply air is filtered, conditioned and dehumidified before it enters the office space through vents at floor level. Exhaust air is drawn through ceiling vents into energy recovery units. ***The air is continually refreshed; none is recycled.*** Green on the Grand's walls were insulated to R-28 and included low-emissivity fenestration and a T8 lighting system with daylighting controls. Furthermore, the building includes a number of environmentally conscious measures ranging from the use of recycled wood and drywall to the installation of low flow water devices equipped with infrared sensors. Most importantly, the building's systems are well integrated.

Identifying the Barriers

If such improvements are possible, what are the barriers preventing them from becoming commonplace. Union Gas sought to determine what the key barriers were by going to the designers themselves and so, In April 1997, Union Gas along with Consumers Gas sponsored a Charrette called, *Building Design For A Sustainable Future,* at the Design Exchange in Toronto. The purpose of the Charrette was to canvass members of the design community on the barriers to designing sustainable, energy efficient buildings. The architects, engineers, developers and building owners and managers in attendance issues identified the reasons why energy efficiency is so often overlooked at the outset. Their 27 points, in Table 2, can be boiled down to three fundamental barriers:

1. emphasis on lowest first cost
2. reliance on traditional methods
3. no market demand

Lowest First Cost. Developers focus on lowest first cost for buildings with little attention to the longer term operating costs, including energy bills. These costs will be borne by the building owner and passed on to building tenants either as rent or allocated on a square footage basis. Features that increase the front end costs such as interactive design processes which balance architectural and engineering considerations and higher efficiency systems and equipment are avoided. Increasingly, competition with respect to design fees has reduced the potential for professionals to give much consideration to higher efficiency alternatives even those which pay for themselves in terms of reduced operating and energy costs. Competition among design firms means that "off the shelf" plans are recycled. There is little incentive for innovation when the objective is to keep costs to a minimum. Designers are reluctant to "go the extra mile" or present options without receiving extra payment for the extra work required to present innovative alternatives. Where alternatives are considered, a higher efficiency feature is usually analyzed on an incremental basis rather than a system basis.

Tradition. The charrette participants were highly self critical, identifying the long standing tradition of "professional silos" as a impediment. The traditional design process is sequential and engineers face a uphill battle to retrofit energy efficient alternatives after the architects have completed their designs. Design teams rarely work as a single, integrated unit. Change does not happen without resistance. Tried and true methods are more acceptable and less threatening to both the industry and professionals. What has worked in the past is comfortable and safe and, more importantly, professionally accepted for liability and insurance purposes. As a result, designers tend to over specify systems and equipment to avoid call backs. Conventional design approaches, construction tools, and building codes may also be too restrictive to meet the challenges of designing a sustainable building.

No Demand. Tenants don't demand energy efficiency and therefore, it has not been considered a premium marketing feature. In fact, energy efficiency and conservation are often equated to lower value and problems such as sick building syndrome. Paying extra for such features is counterintuitive. Yet the opposite is true. A more efficient building can be a more comfortable building, with better lighting, better air quality, and a more controllable environment. If tenants begin demanding sustainable and energy efficient buildings, owners will also and the design community will respond. This will require a building labeling system to alert tenants to the energy and environmental quality of the buildings.

Table 2. Issues Identified by the Design Community

Low Awareness	awareness of new and rapidly changing technologies is low among designers
Design Fee Competition	more cost effective to rework existing building plans with as little innovation and as few revisions as necessary to satisfy the new client's requirements
Belts And Suspenders	engineers tend to over specify systems and equipment to avoid call backs or for liability reasons
Sustainability Costs Money	tendency to equate energy efficiency to lower value, so paying extra for it was counterintuitive
Inside The Box Thinking	tried and true methods are easier for the industry to accept and are less threatening to the existing system and professions
Efficiency Doesn't Sell	by focusing on energy efficiency utilities are putting their emphasis on the wrong selling features.
Linkages	utilities will have to find the right linkages to sell energy efficiency in terms of comfortable, safe, durable, healthy
Split Incentives	benefits of efficiency not realized by those who pay for the improvements.
Professional Silos	various professions in design teams do not work as single, integrated unit
Paradigm Shift	sustainability must be demanded by clients.
No Tenant Demand	increased tenant awareness is required so that they demand and become willing to pay for the value of sustainability
Investment Vs Cost	defined additional costs of innovative techniques in a different manner, perhaps as an investment
Market Pull Vs Market Push	if tenants begin demanding sustainable buildings, owners will also and the design community will respond
Building Codes	performance based codes could result in more innovation.
Incremental Costs	added costs associated with sustainability analyzed on an incremental basis related to the marginal costs and marginal benefits of specific items
Change Resistance	conventional design and construction tools and methods too restrictive
Environment	"sick buildings" are of greater concern to clients/tenants than efficiency
Flexibility	building use and the tenants change over time
Modesty	tendency among innovators to not advertise their successes
Sick Buildings	cost of labeling a building as "sick" is large, more comforting to ignore it
Professional Liability	what has worked in the past is comfortable and safe and, more importantly, professionally accepted for insurance purposes
Cheap Energy	not a significant factor in design and operations
Equipment Focus	sustainability needs comprehensive analysis/interaction with environment
Lowest First Costs	minimum requirements encourage most decisions to be based on costs
No Fear Of Future	without some form of threat, society is slow to act
No Government Push	goal of sustainable buildings not been a high priority in government
Design Costs	designers are reluctant to present options without receiving payment for the extra work required to present innovative alternatives

Study of Design Professionals[3]

The results of a series of focus groups in California are comparable to what was found in Ontario.

- Clients are generally aware of energy efficiency, but lack knowledge of specific opportunities. They are receptive when the design team identifies opportunities, but are less interested when they realize that higher up front costs will result.
- Even the design teams, particularly architects, lack knowledge of specific opportunities and clients are not interested in paying for the cost of having the design team move up on the learning curve. This applies to technologies as well as government and utility program details.
- Design professionals do not view themselves as in the energy efficiency business. In a standard architectural services agreement form, energy efficiency is considered an "additional service", which clients are generally not interested in paying for.
- Program paperwork is viewed as a barrier for design teams as the work falls to them, but the incentives usually go to the owner.
- Timing is critical. Decision-making occurs quickly at the outset of a commercial building project. The later the involvement in the project, the less likely (and more costly) there is opportunity for influencing the design.
- Design professionals are still skeptical about new energy efficient technologies. A proven track record is preferred to justify the incremental investment. Design professions considered assumptions of building operations and maintenance to be suspect yet have a big impact on the realization of savings. Design professionals have no control over how a building is operated or maintained and more often than not, buildings and systems are not thoroughly commissioned. In addition, energy efficient equipment more than likely takes more careful operation and more maintenance.

Breaking Down the Barriers: Union Gas' Approach

What is clear is that a more holistic approach to design, involving all facets of the design team at the outset, can facilitate better integrated designs which are more often than not more efficient. A team approach can create synergies among the different disciplines involved. Good ideas build upon each other and each profession benefits from the inputs of the others. Union Gas is continuing to break down these barriers.

- working with the federal government which has recently issued the Model National *Energy Code for Buildings,* which is comparable to ASHRAE 90. 1 but more relevant to the Canadian climatic conditions. Recently, Natural Resources Canada announced its intention to provide financial incentives of up to $80,000 to designers who exceed the model by 25%. Union Gas has held seminars on the code across Ontario and will assist in marketing the government program.
- working with designers on two more C2000 buildings.

[3] Barakat and Chamberlin

- sponsoring Charrette 98 which saw a fourfold increase in attendance from the design community over the event in 1997. It included leading edge presentations as well as a keynote address by Dr. David Suzuki, Canada's leading advocate for environmental sustainability.
- sponsoring work by the Canadian Standards Association which will go beyond the model code and incorporate a full environmental assessment methodology for new buildings similar to the CSA's *Plus Standard* for existing buildings. This will be marketed to tenants, building owners and developers as a labeling systems for sustainable buildings. The CSA is in discussions with BOMA International and others to broaden the market for the assessment methodology.
- commissioning a study of architectural options for energy efficiency which was released at the 1998 Charrette. It focuses on overcoming these barriers and developing strategies for improved energy efficiency in building design. It catalogues a variety of options and includes case studies from around the world using color photographs of design features. It appeals to architects who are often left out of energy efficiency discussions.

Conclusion

As the next millennium approaches, the "greening" of buildings is not just desirable, it will be imperative if Canada is to come anywhere close to meeting its Kyoto obligations. The good news is that better, more sustainable buildings will be the result. Architects and consulting engineers who position themselves to serve this greening market will finding opportunities in Canada and abroad.

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