AN ENERGY CONSERVATION DESIGN GUIDE FOR COMMERCIAL OFFICE BUILDINGS

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The art or science of designing a building is a process of simultaneously solving a set of problems or addressing a set of conflicting needs. There is no one correct solution, and the whole process is controlled by the design professionals' experience. The whole process is driven by first-cost constraints and operates under two myths. The first myth is conservation costs more. The second myth is that utilities are not interested in conservation.

This paper proposes to demolish these two myths. We have written it to explain our participation in the process to produce a guidebook and to show the energy- efficiency achievements that are possible. However, the real message of the guidebook and of this paper is that a change in the design process is essential if we are going to ensure our energy future. It is only when the owner/ developer, architect, and engineers work together, as an energy-saving team early in the design process that the maximum energy savings can be realized in a building.

In New England, like other parts of the country, the commercial building sector represents the fastest area of growth and the greatest potential for cost-effective conservation and load management. Northeast Utilities (NU) is the largest utility in New England and we are packaging our efforts to stimulate an interest in conservation and load management among architects and engineers during the design process. Under the banner of our Energy Alliance, we are continually working to promote and purchase conservation and load management at a cost lower than the cost of building a new power plant.

The Energy Conscious Construction (ECC) program is one of the programs under the Energy Alliance. Through ECC we are working to build a relationship with the design professionals based on trust and understanding, and to encourage them to incorporate economic conservation and load management measures in their design. As part of ECC, we offer DOE-2 energy simulations at no cost to architects and engineers designing projects over 10,000 square feet in our electric service territory.

The acceptance of the energy simulation service, unfortunately, was slower than anticipated with the major claim by the design professional being that the client is only interested in first cost. Commercial buildings, unlike residential construction, cannot be easily generalized. They vary greatly in size, mix of use, and hours of occupancy. Each building is molded and designed by the architect and engineer to meet the conditions imposed by the client and site. All members of the team are driven by first-cost constraints, including design fees. All are unwilling to spend time and money on something they feel will increase the first cost.

NU's approach was simple: attack the problem head on. We would produce a guidebook that demonstrates that it is possible to design and build an energy-efficient building in our service territory without increasing first cost. The guidebook would be written for the design professionals and would be accurate for their needs. It would be developed and written by a prime contractor who would subcontract for the required expertise.

The prime contractor was a full-service communication/marketing firm. An architectural firm, engineering firm, general contractor, energy consultant, and a graphic designer were assembled as the team. Each were prestigious local firms. We were members of this team.

The concept of the content and presentation evolved during the development of the guidebook. We all knew that it had to stand up to and be accepted by our peers in the design community. We also recognized that there would be other audiences including developers, builders, and corporate facility planners who would be interested in the thesis. It could not be just another "conservation is good" book. We had to demonstrate and prove the effects to a local audience.

The whole process was a team process. All ideas were discussed by the entire team and each was allowed to step outside the restraints of his own profession and defend or criticize as each saw fit, this included the writing of the copy. The strength of the book is that it was a team process from the beginning and team process is the key message contained in the guidebook.

The first step was to design a 60,000-square-foot office base case office building. Great effort was expended to make sure that we did not create a design that would destroy the concept before we got started. The design exceeded the minimum building envelope standards. The base case building turned out to be a three-story structure with a main atrium, ribbon windows, and some interesting architectural features.

We ran a DOE-2 energy simulation on the base case building to establish the peak heating and cooling loads and the annual energy costs. An estimated construction cost was also developed. We then created potential energy-saving strategies by changing only one variable at a time. For each strategy an energy simulation was run and a cost estimate was developed. Approximately 50 strategies are presented in the guidebook along with the essential energy and construction data. A description of the strategy, an explanation of the results, and our conclusions are presented for each strategy.

We then designed our improved base case building. We selected those strategies that gave us the best energy performance but did not result in an increase in the estimated construction cost. The combined measures in the base case building reduced the electric demand by 51 percent, the electric energy consumption by 36 percent, the total energy consumption by 32 percent, and the total energy bill by 37 percent. All was accomplished without increasing the estimated construction cost. Table I shows the energy consumption, the total energy cost, the peak cooling load and construction cost of the base case building, some individual strategies, and the improved base case building.

TABLE I

Building	Annual kWh Thousands	Annual Ccf	Estimated Annual Energy Cost	Peak Cooling Load Tons	Estimated Construction Cost
Base Case	951	2,965	85,311	141	3,860,000
Reduced Glazing Area	936	2,268	82,836	131	3,825,000
Beige Color Brick	950	2,967	85,250	140	3,860,000
High-efficiency VAV	898	2,965	75,939	141	3,877,500
High-efficiency Lighting	697	4,823	66,297	118	3,850,000
Daylighting Controls	879	2,489	78,183	123	3,830,000
Improved Base Case	607	3,475	53,674	94	3,860,000

We recognized that not all developers or owners are interested in building the "typical" office building and thus developed the village cluster concept. The concept created three separate buildings containing the same useable square footage plus a partially conditioned atrium. The village cluster was designed without increasing total estimated construction costs (excluding site work). This concept reduced the electric demand by 17 percent, the electric energy consumption by 31 percent, and the total energy bill by 10 percent over the improved three-story base case building. Table II shows the energy consumption, the total energy cost, the peak cooling load and construction cost of the base case building, the improved base case building, and the village cluster concept. Table III compares the annual Btu/sf for these three 60,000-square-foot buildings.

TABLE II

Building	Annual kWh Thousands	Annual Ccf	Estimated Annual Energy	Peak Cooling Load	Estimated Construction Cost
Base Case	951	2,965	85,311	141	3,860,000
Improved Base Case	607	3,475	53,674	94	3,860,000
Village Cluster Concept	419	6,999	48,363	76	3,725,000

TABLE III

Building	Annual Btu/sf Thousands
Base Case	59.1
Improved Base Case	40.5
Village Cluster Concept	35.8

The purpose of the guidebook was to demonstrate that an energy-efficient building can be designed and constructed without increasing the first cost. We used the office building as the vehicle because it suited the needs of the NU service territory. We have proven our point. However, if the design professionals use the guidebook as a cookbook without thinking about energy, we would have wasted the money developing the guidebook and our time coming here to California.

If, however, the design professionals are challenged and begin thinking about energy early in the design, we have begun to permanently save energy in the future. Their creativity could then be applied to saving energy in all projects that they design. This fundamental change would advance the current design practice and would ensure an energy-efficient economy.

We opened this paper saying that the real message is that only when the owner/developer, architect, and engineers work together as an energy-saving team early in the design process can the maximum energy savings be realized on a building. The team process is how we did it in the guidebook. We hope that this message came through in the paper and further hope that when you do set up your design teams that they include a utility representative (at least in the NU service territory).