ENERGY MANAGEMENT RETROFIT FOR ARLINGTON INDEPENDENT SCHOOL DISTRICT

by

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ABSTRACT

Like many school districts in the southwest, the Arlington Independent School District (AISD) felt a need to upgrade their schools to maximize their value for the gas and electricity being used. They felt they needed to make sure that energy was not being wasted and that any energy conservation measure implemented would provide good payback for the investment made by the school district.

After conducting an extensive search to determine the best way to identify and implement energy conservation strategies, the school district selected Johnson Controls, Inc. as the company they felt could best help them achieve the goals that they had set. AISD also requested help in identifying the best way for the school district to finance the measures taken and for the tracking of the measures to make sure the desired energy conservation goals were met. Finally, the school district requested, a guarantee that expected savings goal be attained by an agreement that the contractor pay for any "shortfall" in savings that might occur.

The contractor was initially assigned the ten schools which seemed to be the most wasteful within the school district. With their personnel, loads and energy users within the schools were identified and quantified. From this information, areas where energy was being wasted were identified and ways of eliminating waste were examined. If a reasonable payback and a means to measure the payback were identified, then it was included in the list of measures to be presented for consideration; if payback was high, or could not be effectively measured, then that conservation measure was discarded.

After all energy conservation measure ideas were gathered, they were presented to the school board with a suggested method of payment, so the best return on investment for the district could be achieved. Also, a written guarantee was made available, so the school district could feel certain that in whatever conservation measures selected, desired results would be achieved.

During the construction phase, special attention was given to ensure classes would be disrupted as little as possible and the work would be completed on schedule.

After construction, the contractor monitored savings results and has shown that this project, which represented an investment of well over a million dollars, will provide payback on time, or in advance, of the original estimate.

INTRODUCTION

The Arlington Independent School District (AISD), as does many Texas school districts, has been faced with the ongoing problem of maintaining satisfactory comfort levels and high levels of equipment maintenance, while also seeing that budget items such as utility costs, preventative maintenance costs, and repair costs were kept at a minimum. This paper addresses the way in which that school district chose take a very active role in controlling the direction in which their school district moved in order to reach their goals, both short term and long term. Readers should be able to gain a basic insight into a source of action that will enable parties responsible for goals similar to those of the AISD to meet their needs and to allow them to bring about the necessary actions needed to put the measures into practice.

IDENTIFYING ENERGY SAVINGS

How does a school district, or anyone else, determine the optimal way in which to identify and make needed changes to their building or buildings? How can an efficient, cost effective program be implemented so that the owner is sure that when energy conservation measures are identified they can be installed at a reasonable cost with minimal disruption to school personnel from funding that may or may not be readily available? And very importantly, how does the owner go about insuring that the energy conservation measures actually do what they were intended to do? How does the owner get a guarantee that money actually will be saved if they go ahead with the measures?

The AISD had experienced mixed results in the past whenever they had put new equipment into their buildings to save energy. Sometimes they were able to see that they had achieved desired results with what they did. At other times it appeared the conservation measure actually did not achieve desired results. And at times, it was difficult to see what effect had been brought about. Everything seemed just about the same.

No matter what conservation steps were taken, one thing remained constant: Whether the conservation measure worked or not, AISD paid for everything. There was no guarantee from anyone that when everything was installed that the desired results would occur. This, coupled with the fact that AISD was in the education business, not the energy conservation business, made for a slow and hazardous course in trying to reach their conservation goals.

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For these reasons, AISD decided that they would investigate the possibilities of using performance contracting to help them with the energy conservation goals in their district. They had heard that performance contracting could increase the efficiency with which energy is acquired, distributed, and consumed using technologies such as computerized energy management systems, boilers, chillers, lighting systems, and improved control equipment. They had also heard that performance contracting would possibly provide a guarantee to them that if conservation measures were implemented, that desired results would occur. If the results did not occur, the performance contractor would be required to make up the shortfall and thus allow them to meet their conservation goals.

In order to determine who to use as their performance contractor, AISD requested quotations from interested parties that based selection upon a strict criteria of engineering skill, recommended energy conservation measures, payback amounts and time frames, and guarantees. The ability of the contractor to provide funding for the project and competitive interest rates were also a consideration of major importance.

Proposals were presented to the school board and after a period of study and investigation, it was decided that a performance based contract be awarded to make changes in ten AISD school buildings. Also, they would require the contractor to compensate the owner for any and all shortfalls in savings that might occur. Further, all engineering, installation, monitoring of savings, and in most cases maintenance of the new equipment would be done by the contractor. Additionally, the owner was allowed to have the flexibility to change the use of buildings, the operation times of the buildings, and setpoints of controlled areas so long as one weeks notice was given to the contractor to allow for needed adjustments to the monitoring of the savings results for the building.

The contractor, using their personnel, performed energy audits on each of the buildings in question and identified and quantified the present energy consumption in each of the ten schools. They then constructed a computer model of each building using "EFACT", a company developed software program that was fine tuned for this customer. This program insured that proposed changes could be implemented by software to see what their effect on energy savings would be upon the buildings and upon each other. (Whenever more than one energy conservation measure is implemented in a building, there is a strong likelihood that there will be an interaction between the measures. It is important to know what this interaction might be.)

The schools which were surveyed were either primary or secondary educational facilities. All the schools were either one or two story constructions containing classrooms, administration, and athletic facilities. The age of the buildings studied varied from five years old to thirty years old. The HVAC systems in these schools were typical of those found in educational facilities, except that one school had a direct digital control system. In general, these buildings were constructed before energy costs became as important as they are today. As a result, it did not come as a surprise that most of the systems were very energy intensive in use.

Several of the schools in this study were constructed in the 1970's when an "open classroom concept" was in vogue. Since that time, many renovations have taken place in these facilities. Some of these renovations included the addition of doors, walls, and partitions. These changes affected the original air distribution design of these buildings and were causing many comfort problems.

During the development of the computer models, it became clear that the sizes of the original heating and cooling plants did not match the existing building heating and cooling loads. In almost all cases, it was found that the heating plants in the schools were two to three times the necessary size. This appeared to have been designed as back-up capability and did not seem to have a use in future expansion. In several schools, it was discovered that the cooling plants were not designed to keep all areas of the building cool simultaneously. These factors were taken into account and in some instances proved very useful in achieving savings.

It was discovered that during the previous three years, a comprehensive maintenance and repair program had been implemented throughout the buildings. Obvious gains in improving the condition of both the mechanical and electrical systems had been made; however, serious problems still exist in some areas and the condition of some equipment was very critical. The performance of this equipment also had to be brought up to standards if energy conservation was to be successfully achieved.

As would be expected, usage of these buildings was at a maximum during the normal school day of 8:00 AM to 4:00 PM, in the months of September through May. Numerous activities occurred during other periods of the day; athletic activities, special events, community activities, faculty training, maintenance and cleaning, and many other uses. All these activities caused significant energy consumption above and beyond that required for the normal school day. This additional energy consumption was higher than actually necessary due to the poor utilization of existing facilities for these activities. The survey did not discover any straight forward conservation measures which could be used. However, certain possibilities existed which were considered:

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1. Many of the school facilities contained several temporary portable buildings in addition to the main school building. These buildings could be used for many after school, weekend, and summer activities. Although the temporary buildings themselves are energy inefficient, less energy would be used operating these buildings, rather than large areas of the main school building, which requires large areas to be air conditioned.
2. Numerous activities, such as faculty training, night classes, community services, etc., were scattered throughout the school district in various facilities. These buildings were under-utilized. Significant energy conservation could be achieved if many of these activities were be consolidated into fewer facilities.
3. Each school did not use energy at the same rate, the same efficiency, or at the same cost. For this reason, consideration was given to holding activities in the most efficient facility whenever this option was available.
4. All schools were partially occupied far beyond normal operating hours to allow custodial crews to clean the buildings. These crews worked until midnight on weekdays and throughout the summer during daytime hours. This use of the facilities caused additional energy consumption. Although this consumption was much lower than full occupancy, it was not insignificant. Reduction in the time required to accomplish these activities provided tangible energy savings.
5. Often times, when more than one after hours activity occured in the same facility, they were scattered such that most or all of the buildings' systems were required to operate. This was extremely inefficient as large areas of the building had to be heated or cooled when occupancy was at a very low level. If these events were consolidated into one building, then the remaining areas could be shut down. Significant energy savings could then be obtained.

The response time to service calls and work orders was frequently mentioned by the school administrators as an on-going problem. Obviously, this caused frustration among those responsible for operating a school. Additionally, delays in repairing mechanical breakdowns caused occupant discomfort and unnecessary energy waste.

The energy conservation study included a review of building walls and roofs. A common denominator in nearly all of the schools was inadequate insulation and a high degree of infiltration in most of the exterior surfaces. This increased both the heating and cooling losses in these facilities which led to increased energy consumption. Our study was unable to discover any economical measures to improve this condition due to high retrofit costs. However, if any structural or roofing improvements were planned, or in the case of any new construction, improvement in wall and roof insulation quality should be seriously considered. (Lower cost of installation at the time of exterior surface erection would make these measures cost effective.)

As stated earlier in this paper, many buildings and their mechanical systems had been in place for relatively long periods of time. Much of this equipment was nearing or had passed the end of its normal life expectancy. This caused increased maintenance costs and energy consumption due to mechanical wear and the lower efficiencies of older equipment. It was recommended that a program be undertaken to replace this aging equipment as it failed, rather than engage in continued expensive repairs and maintenance. More modern and efficient equipment would be considered in all cases. The improved energy efficiency and lower maintenance would pay for much of, if not all, the cost of replacing these systems.

After the buildings surveys, the computerized model was designed for each school and simulated the utility consumption with an accuracy of +/- five percent. Specific energy conservation measures were then defined and those most likely to provide the highest savings were entered into the data base. These measures were then simulated to determine which mix gave the highest return on investment and which mix provided the highest return for the owner provided investment criteria.

To complete the study, costs were firmly established for the energy conservation measures. Comparing these costs with the dollar savings generated in the engineering model, payback terms were established and applied to both individual and composite energy conservation measures. Projects were then selected on the basis of those which gave the highest return on investment and which benefited the owner most.

The total savings of all energy conservation measures elected for use by the owner had projected savings of about $226,000 per year. The total cost of all energy conservation measures implemented was $870,000. Though this investment appears large at first blush, it has a simple payback of 3.85 years.

A financial package was put together and structured so that the AISD was able to gain a very strong increase in positive cash flow from the money that they no longer would be paying to the utility companies. This was because the yearly installment payments for the new equipment and improvements was less than their guaranteed savings.

At the end of this paper there can be found several charts that show both "before" and "after" examples of utility consumption and also how this consumption relates to dollars saved. (Fig. #1, #2, and #3) Figure #4 shows the discription of work done at each of the schools.

The AISD has been the beneficiary of its good planning because they were willing to try new ideas. They used innovation to secure savings and new equipment that was needed.