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Texas School District Energy Management: The Status of Energy Management in Texas Schools



Texas School District Energy Management Study:

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Introduction:

School energy management programs can play a vital role in reducing operating costs and improving classroom productivity. School districts in the United States spend approximately \$12 billion per year on energy bills with one-third of this amount being wasted due to inefficient building operation and behaviors (DOE). Further, energy utility budgets are typically the second largest budget item for a school district behind teacher's salaries (NASB). This line item can be the easiest to lower with the implementation of an effective energy management program. Further, an effective energy management program can significantly improve student and teacher performance by maintaining ideal learning room temperatures and improving indoor air quality¹.



A panel by the National Academy of Sciences finds that although we would assume that for economic purposes organizations would carefully manage energy consumption, organizations frequently do not optimize energy efficiency because of lack of precise energy use information and conflicting interests within the organization². However, a variety of methods are available for a district to lower its energy consumption including data analytics and benchmarking, low-cost/no cost options like retro-commissioning, behavioral management programs and capital projects. All of these components can be put into play via effective energy management programs and policies. However, little is known about the state of energy efficiency

management programs in school districts or the effectiveness of such programs. To help school districts realize the 20% to 30% energy budget line savings, it is important to understand what programs and initiatives are most effective at reducing energy consumption. This knowledge will help existing programs to better develop their programs, as well as provide information and resources for those who are building a business case to begin a new program or grow an existing one.

Study Overview:

In 2013, a study was initiated by HARC to develop a better understanding of the state of energy management programs in Texas School Districts. The intent was to determine the status of energy management programs in the state and to determine how district policies, organizational structure and resources that comprise an energy management program influence energy consumption. To gather the required information, HARC conducted an online survey of Texas School Districts. All school districts were eligible to participate in the survey. The survey was presented to the school districts with the assistance of Texas Association of School Business Officials (TASBO), the Texas Energy Managers Association and the Texas Education Service Centers. In total, 60 school districts responded. The school districts represent small rural districts, large suburban districts and inner-city urban school districts.

Results:

¹ The ideal temperature range for learning is between 68 degrees to 74 degrees. Room temperature outside of this range has demonstrated a significant reduction in test scores, approximately 14% to 18% (EPA). Also, improved air quality through better ventilation has demonstrated a 15% increase in test scores (EPA).

² Stern, Paul C. and E. Aronson, 1984. "Energy Use: The Human Dimension." Freeman, New York.



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Building Portfolio:

Across the state of Texas the size and age of a school district's building portfolio vary considerably. In our survey, we were able to get a wide sample of school districts. The sample included rural, suburban and urban school districts. The sample's average age of school district's portfolio in the state is 26 years with half of the reporting school districts with a building portfolio over 25 years old³. According to a study by the National Center for Education Statistics⁴, school buildings between 20 to 30 years of age are typically in need of significant equipment replacement and repair if original equipment still remains in the building. Over 10% of Texas school district portfolios have average building age over 40 years. Schools over 40 years old in age begin to experience rapid deterioration in mechanical, electric, plumbing equipment.

- Average Age: 26 years
- Average Number of Buildings: 33
- Average Size of District: 4.6 million sq/ft

In this study, over 182 million square feet of district space is represented. The average square footage under management by school districts is 4.6 million square feet.

School District Energy Consumption

In 2007, the Texas Legislature passed HB 3693 requiring all school districts to reduce energy consumption by 5% and to make their utility consumption available to the public on a yearly basis. Although there has not been 100% compliance, most of the districts have complied. This requirement ensures school districts pay closer attention to their utility consumption and increases transparency of utility consumption by the school districts. Because not all school districts were reporting yearly utility consumption, in our survey we requested the school districts electricity consumption, natural gas consumption and square footage of district. For those responding, we compared the data with what was reported on their web sites and found some minor differences. We attribute these differences to after the fact adjustments that occur as billing errors are identified and reconciled.

The most common unit of measurement for energy management is energy use intensity (EUI), kBtu per square foot. This measure along with cost per square foot and cost per student are used by many schools to benchmark their facilities. With the data collected, we calculated the EUI for each district. For the respondents in this study the EUI median was 44 kBtu/square foot. (see chart 1) The EUI ranged from 26 at the lowest to 69 kBtu/square foot at the high end. Based on studies conducted by the Council of Great City Schools⁵, reporting an EUI for school districts at 52 kBtu/square foot, and the EPA, reporting an EUI of 68 kBtu per square foot, Texas schools are performing relatively well compared to other school districts nation-wide. However, it must be pointed out that the wide range in EUI across reports could be attributed to differences in weather and climate, building type/size and operational characteristics. To reduce this variability and to allow for better comparison across the United States, the EPA has deployed its Portfolio Manager

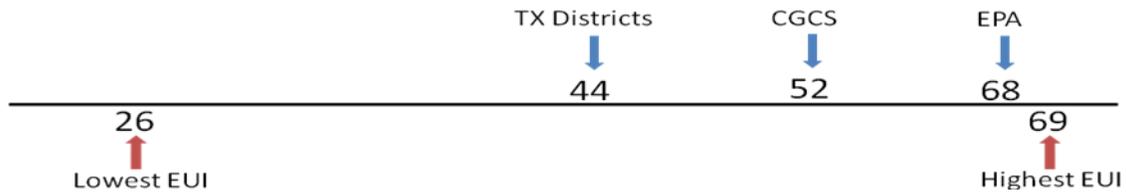
³ The average age found in this study's sample is in line with a similar Texas School Facility survey conducted in 2005 (Taylor et al, 2005)

⁴ Rowand, C. 1999. "How Old are America's Public Schools?" National Center for Education Statistics.US Department of Education, Office of Research and Improvement.

⁵ Council of Great City Schools, 2010. "Managing for Results in America's Great City Schools: A Report of the Performance Measurement and Benchmarking Project."



Chart 1



to develop a national standard for benchmarking facilities removing much of the variability that is seen in EUI across studies⁶.

Further, this survey was open to all school districts which could result in a selection bias where primarily energy managers with energy programs are responding. The expectation would be that these energy managers would likely be at districts with lower EUIs than districts without energy managers. However, we find that almost a quarter of the respondents were from districts without energy managers. Further many of the districts without energy managers had some of the lowest EUI of the total sample, ranging 26 kBtu/square foot to 48 kBtu/square foot. Only one of the districts without an energy manager had a EUI higher than the sample median.

Energy Management Staffing

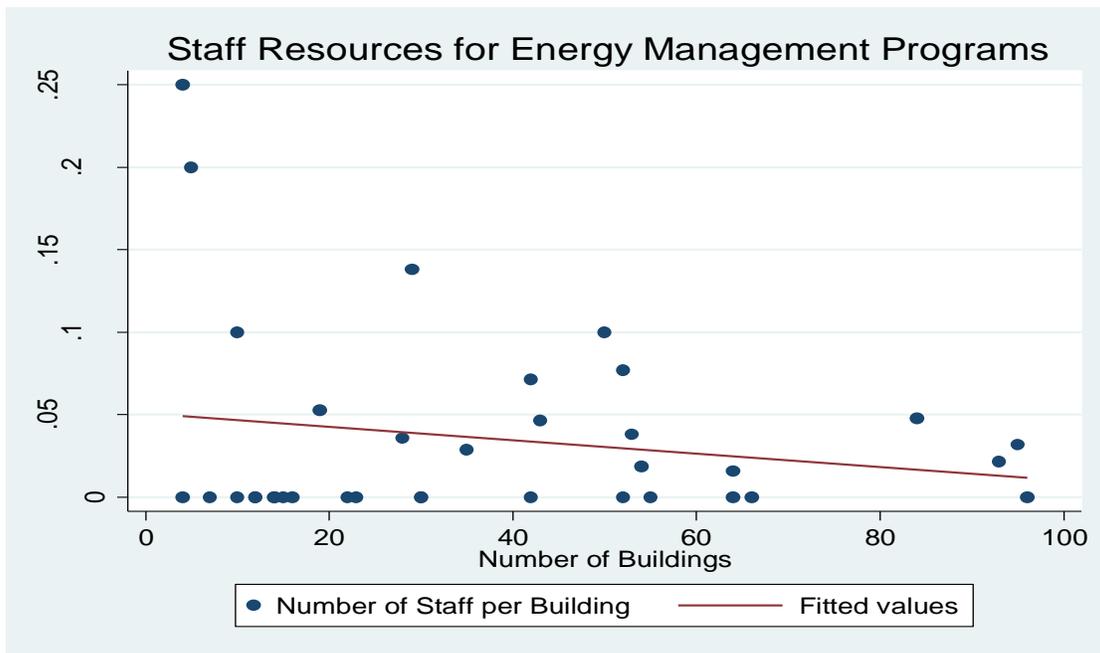
In our survey of Texas School Districts, 88% of the reporting districts had some type of energy management program in place and 76% had an energy manager. 24% of the Districts did not have an energy manager or energy management staff. The quality and complexity of these programs, however, vary considerably across the districts. The average length of a school district's energy management program was 10 years.

The level of support provided to energy managers and energy management programs varied considerably across the districts. Over 29% of the districts did not provide additional staffing support to its energy manager. Those programs that did provide additional support typically had two employees reporting to the energy manager. In our analysis, we were not able to identify a significant relationship between the number of staff and EUI. Further, an optimum number of staff for an energy management program has not been established. We would anticipate with greater automation, particularly with utility bill management and energy information management systems, the number of staff required in these roles may decrease. However, as demonstrated in chart 2, we do see a decrease in support as the number of buildings in a district portfolio increases.

⁶ www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager



Chart 2

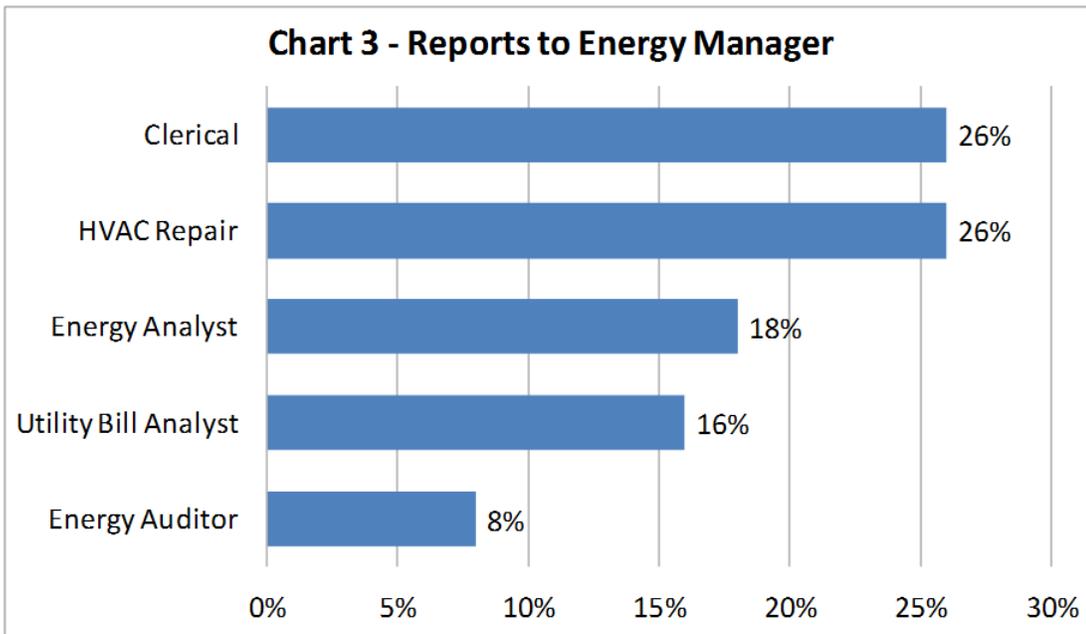


For the energy management programs receiving support, the most common support provided was clerical support and HVAC repair. Twenty-six percent of respondents reported having clerical support for energy management and 26% reported having an HVAC repair technician reporting directly to the energy management program. Eighteen percent reported having an energy analyst on staff and 16% had a utility bill analyst. Finally, eight percent had an energy auditor on staff. (see chart 3)

Further, districts with clerical support typically had some other additional support. For example, 83% of districts with a utility bill analyst had clerical support, 71% of Districts with Clerical Support have energy analysts; 100% of districts with auditors had clerical support; and 50% of districts with clerical support have an HVAC technician.

We find that when a District has a HVAC technician on staff there is typically a lesser likelihood of having additional staff. For example, 30% of the Districts with an HVAC technician also had a utility bill analyst; 45% had an energy analyst and 20% of districts with a tech had auditors. With an average salary of \$47,000 for an HVAC technician in Texas, it is quite possible that the expense of having a certified HVAC tech on staff may decrease the likelihood of hiring additional support staff.





We also considered how having different positions reporting to the energy manager may influence the energy use intensity. We find that energy management programs with an HVAC Repair person has a 10% lower EUI than programs without an HVAC Repair. We also find that programs without clerical staff had a 15% lower EUI than programs with clerical staff. However, we feel additional study is required to further tease out why having these different staff positions would lead to such a large difference between programs with and without these staff positions.

Certified Energy Managers and Personnel

Recently there has been a significant push to have a Certified Energy Manager (CEM) on staff or an Accredited Texas Energy Manager (ATEM). With this interest, we wanted to see the status of certified energy managers in school districts. We find that 66% of energy managers are Certified Energy Managers. Further, we find energy managers to be well educated and relatively new to energy management. Our study indicates that 65% have a college diploma and 30% have a graduate degree. As far as years of experience we find that energy managers have on average 7.5 years of experience with 45% of energy managers with five or less years of experience and 30% had less than three years of experience.

With focus by school districts on certified energy managers, we were interested in determining their role in influencing the energy use intensity of the district. We find that school districts with Certified Energy Managers (CEM) tend to have higher energy use intensity than school districts without CEMs. This finding was at odds with expectations. We conducted additional analysis and found when taking into account the size of the school districts the finding made better sense. Certified Energy Managers tend to be in larger school districts. There is a strong positive correlation between CEM and the square footage and number of buildings in a district. Nine of the ten largest school districts reporting have a CEM. The size of the district itself can make it very difficult to manage resulting in higher energy use intensity, particularly if there is minimal staff and resources to support the energy manager, which there tend to be. The 10 largest schools had on average 3 employees supporting energy management programs, with 30% having no supporting staff. In total, over 50% of the reporting school districts did not have any supporting staff for energy management.

Why Start a Program:



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We were also curious as to why a school district would start a program. We find that 88% of districts started an energy management program to save money (see chart 4). This is not a surprising finding as it has been widely documented and communicated that effective energy management programs can save 20% to 30% on utility costs. Further, we know that there is a considerable amount of energy waste in school districts. According to the EPA, school districts spend over \$12 billion a year for energy utilities with one-third of that amount being wasted. Further, with the significant budget cuts faced by school, \$5.4 billion was cut from the budget in the 2011 legislative session, school districts were forced to identify all areas where they can reduce costs and use savings to retain teachers and purchase necessary materials and supplies.

Other reasons given to start a program beyond saving money include, thirty percent started a program because it was the environmentally responsible thing to do; twenty percent because they are legally required; seven percent to improve academic performance; and two percent claimed to have started a program because of public pressure. However, for all of these schools that started a program for these reasons, financial considerations were also included and largely the initial trigger for adopting an energy management program.

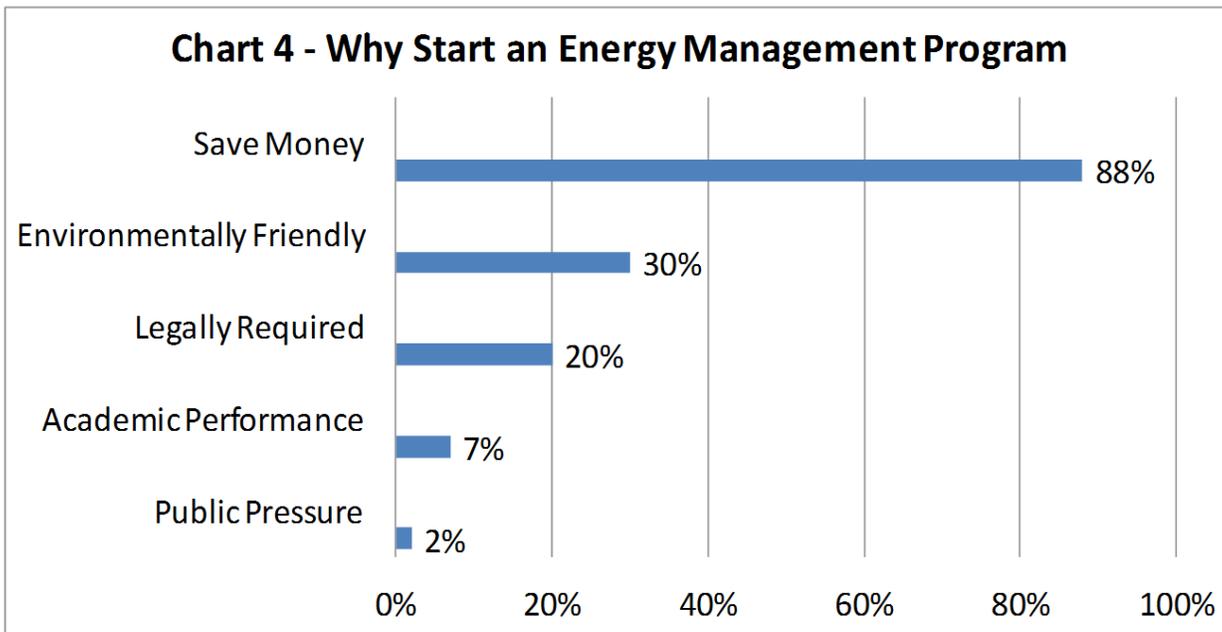
Anticipated savings, rather than legislation largely drove adoption of energy management programs. There is minimal indication that the passage of this legislation drove any significant adoption of energy management programs. Many of the districts had already taken action without the legislative requirements. All surveyed districts with an existing program had already started a program prior to 2007. However, there is no doubt that the state level technical assistance, utility program incentives and goal setting requirements that came about because of this legislation made the programs easier to implement, likely improved return on investment and increased district accountability and transparency.

Also, an interesting finding is that academic performance was reported to be a trigger for energy management programs for newer programs. This increased awareness is likely due to increased focus on school environment and student performance. We are interested to see in future studies if this trend will continue. It has been demonstrated that teacher and student performance is significantly affected by room temperature and ventilation. Studies by the EPA have found that the ideal temperature for learning is between 68 degrees and 74 degrees. When temperatures fall out of this range, there appears to be a significant decrease in test score performance, approximately 14% to 18%⁷. Further, an additional EPA study finds that improved ventilation rates can improve test scores by approximately 15%⁸. Appropriately developed and implemented energy management programs can help tremendously in ensuring that mechanical systems and the building envelope are properly maintained and operated to sustain optimal temperature and ventilation in classrooms.

⁷ <http://healthyschools.cefpi.org/temperature.html> and <http://media.cefpi.org/hps2009/GunnellEnvironmentalQuality.pdf>

⁸ http://www.epa.gov/iaq/schools/student_performance/evidence.html





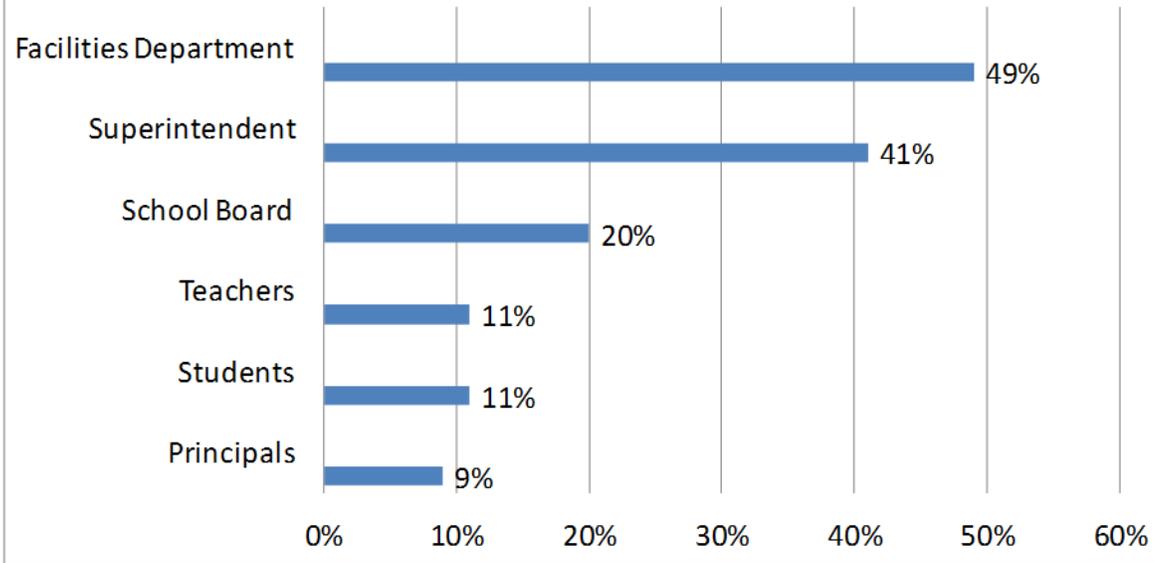
Energy Management Champions:

The success of energy management programs may be largely determined by who champions and supports the program. In this study, we find that the facilities department is the largest champion of energy management programs. Forty-nine percent of school districts reported the facilities department was what drove the start-up and implementation of the energy management program. The second largest champion was the superintendent, at 41% followed by the school board at 20%. (see chart 5) These findings coincide with what we found as the primary reason to start an energy management program which was to reduce operating costs. Those individuals in the schools, i.e. teachers, students and principals, did indicate some support but not to the degree of the administration. We contend that the lack of support at this level could be due to lack of understanding by those in the school as to how an energy management program could help student performance and school comfort levels. Further, there is a greater focus on academics and learning in the schools and less on building operation and maintenance. As energy management programs develop and are able to demonstrate their ability to significantly improve student performance, it is likely that more support will be demonstrated at the school level.

In this sample, we also wanted to see if there is a correlation between energy management champion and energy use intensity. We find that there is a significant correlation between who champions the program and EUI. When a superintendent champions a program the EUI is typically 10% less than if the superintendent is not the champion. We do not find a significant correlation between others championing the program and influence on EUI.



Chart 5 - Who Champions the Program?

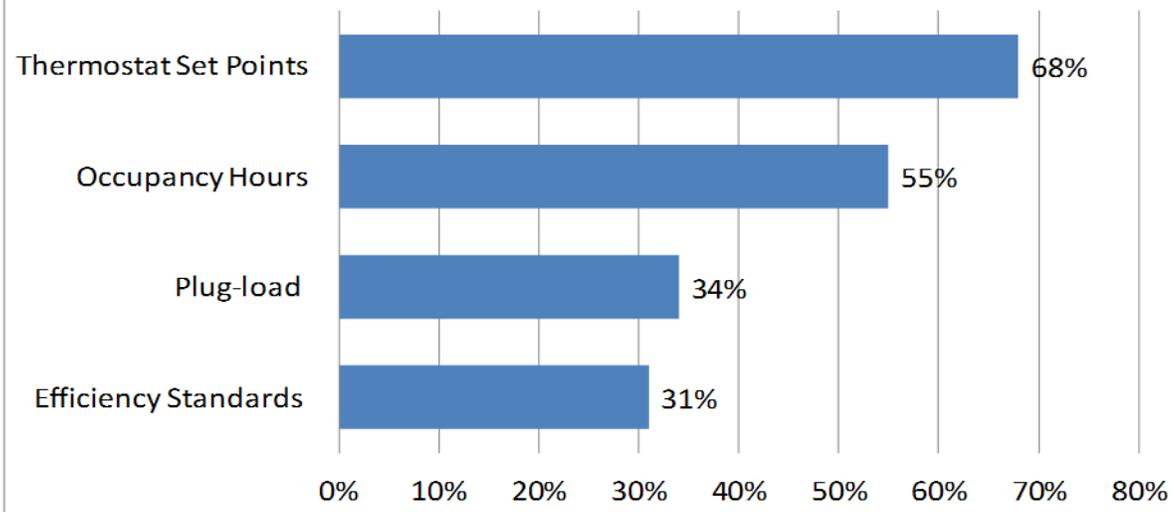


Energy Management Policy:

An energy management program policy should drive much of the energy management decision making in a school district. An energy management policy is defined as having policies that direct facility maintenance and operations in temperature set-points, building occupancy hours, plug-loads and/or efficiency standards for equipment. In this study, we see that 74% of the reporting Districts have an energy management policy in place. The most commonly adopted policy was the thermostat set-point, where 68% of the districts reported having this policy. Followed by occupancy hours, at 55%; plug-load policy at 34% and equipment efficiency standards at 31%. (see chart 6)

Of the districts with energy policies, only 10% covered all four. The median number of adopted policies was two policies. The most common combination of policies is the thermostat set-point and occupancy hours.

Chart 6 - Energy Policy

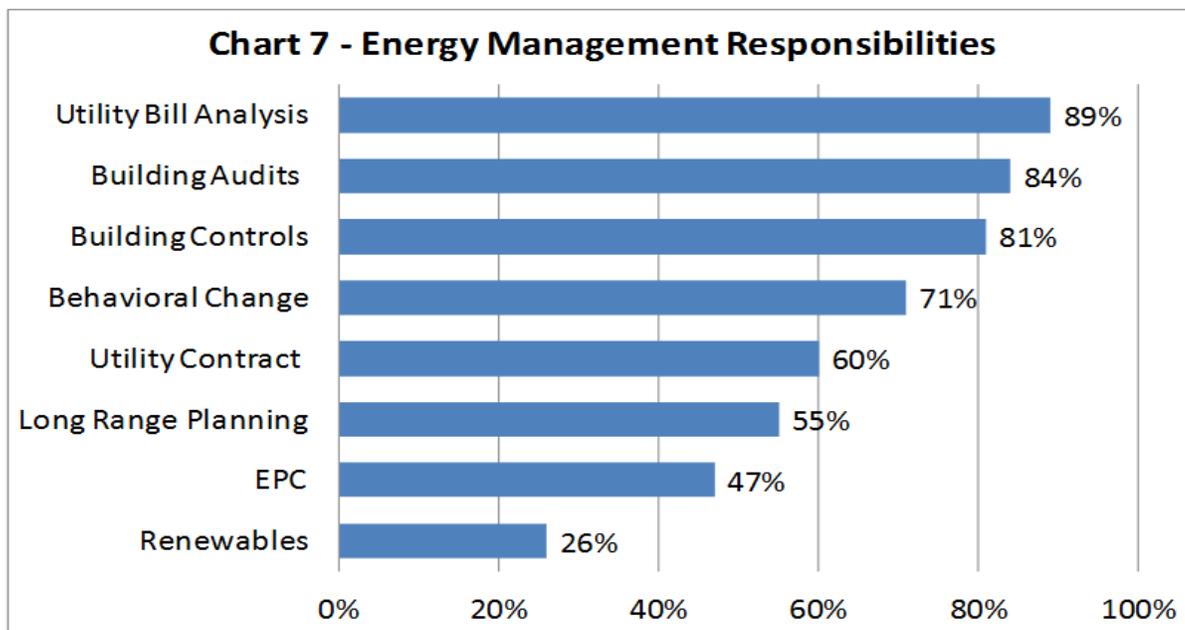


Energy Management Responsibilities:

Energy management programs have a large number of responsibilities. We asked about the responsibilities of each of the energy management departments and found that the most common responsibility is utility bill analysis, at 89% of school districts. Following closely behind is responsibility for conducting building energy audits and managing building controls, 84% and 81%, respectively. Unfortunately, we were not able to determine the actual activity or quality of these programs. (see chart 7)

We were curious to determine how having these responsibilities influence the districts' EUI. There appears to be no significant correlation between EUI and the specific responsibilities of an energy management program. Further, assessment of individual districts would likely indicate otherwise. We would expect that the lack of relationship in this sample is due to significant variance in the resources and capabilities of these school districts, indicating a need for the investment of greater education and resources to build energy management capacity.

Having a policy may matter in the responsibilities of an energy management program. When considering the influence of the energy policy on energy management responsibilities, we find that 88% of those districts with a set-point in their energy policy place the responsibility of building controls with the energy management department. Further, there is a strong positive correlation between long-range planning and participating in an energy performance contracting project.



Behavior Management:

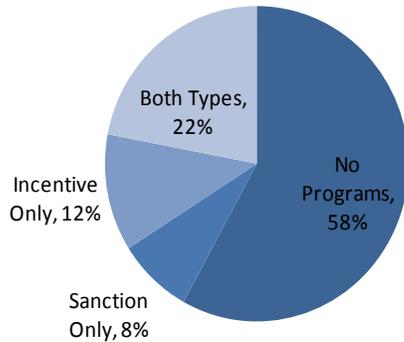
With tight school budgets, large capital expenditures to improve or upgrade facility mechanical and lighting equipment is difficult. To this end, we wanted to better understand how low cost/no cost options like behavioral energy programs will influence a school district's EUI. Many studies have considered the effectiveness of behavioral programs at individual schools through qualitative analysis and case studies. This paper considers the effectiveness of behavioral management programs at a school district level and considers these programs in over 38 school districts. The school districts in this sample are small rural districts, large suburban districts and urban school districts. The diversity of size and type of district allows for a more comprehensive assessment of the effectiveness of a behavioral management program.



The behavioral mechanisms considered were incentives, recognition, sanctions and notification. Both incentives and recognition have a more positive appeal and attempt to drive behavior with positive reinforcement. Sanctions and notification focus more on penalizing those that were not complying with district energy management programs.

To understand the relationship between EUI and behavioral programs we conducted a regression analysis. We had

Chart 8 - Behavior Management



energy use intensity as the dependent variable. For the independent variables we have behavior program type variable, allowing us to measure the type of program. In our sample 42% of the school districts had an energy management program. See chart 8. We also controlled for building factors and management by including a control for age of building and whether the district had a certified energy manager.

Our findings indicate that behavioral management programs do matter, but it is a specific behavioral approach that is most important. Programs with incentives and recognition result in a lower EUI per district than programs without incentives and recognition. See chart 9. Programs with behavioral incentives typically see a 10 point lower EUI than districts without an incentive program. Programs with sanctions alone, do not have a significant influence on EUI.

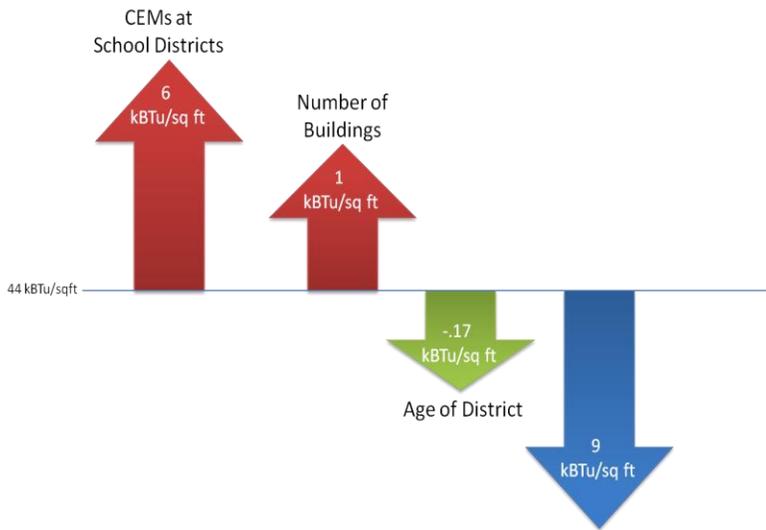
We also find that the age of a districts building portfolio is significantly and negatively related to EUI. Schools with older building portfolios see lower EUI than districts with newer building portfolios. A year increase in the average age of buildings in the school district would result in a .17 decrease in EUI. We anticipate that this is the case due to two reasons. First, new ASHRAE standard for indoor air quality have significantly increased the amount of fresh air coming into newer or newly renovated buildings. This requirement can significantly increase energy costs, particularly in humid climates. Second, newer buildings have significantly more volume. This can be seen by the cavernous common areas and entrances that are not as prevalent in older schools. Energy managers have started to take note of this significant difference and have begun measuring their EUI not by square footage, but by volume. This is likely to provide a better measure of energy use intensity of the building. Finally, chart 9 indicates that a district with a CEM will typically have a EUI that is seven points higher than a district without a CEM. As we suggest above in the *Energy Management Staffing* section this has more to do with typically seeing CEMs at larger school districts that are more complex and difficult to manage.

37% receive percentage of savings back to their schools



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Chart 9 - Change in EUI



Conclusion:

Energy management in school districts is a very important topic area to discuss. Effective energy management programs can significantly reduce the energy consumption of schools resulting in significant cost savings and emission reductions. Effective programs can also ensure that students and teachers have a comfortable learning environment. This study is a first step in understanding the state of school district energy management programs. Based on this study, we find there is a significant amount of activity occurring in Texas school districts. Many of the school districts have active energy management programs that are working to reduce energy

consumption, as well as work to improve student performance.

Although, this study provides an interesting picture of district energy management study, we were not able to get a good idea as to the effectiveness of these programs, nor determine best practice recommendations. We did find that behavioral programs do lower EUI and that incentives do matter as part of the behavioral program. We are now ready to take the next step and determine the effectiveness of these programs. Currently, we are working on a project with the American Council for an Energy Efficiency Economy to develop a better understanding of the effectiveness of district energy management practices across the United States. Further, through this study we will be able to develop a better idea of best practices and provide this information to key stakeholders.



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