Scoring Our Schools: Program Implementation Lessons-Learned From Benchmarking Over 1,775 Schools for Seven Utilities

Jim Stimmel and Jessica Gohs, CLEAResult Consulting, Inc.

ABSTRACT

Over the last two years, CLEAResult Consulting has benchmarked the energy performance of over 1,775 schools in seven electric utility service territories. The benchmarked schools include all school districts in three of the utility service territories and a small percentage of the districts in the other four. This paper presents the findings and lessons-learned from the benchmarking analysis and is focused on impacts of program design, effectiveness, implementation, and results rather than technical methodology.

Our benchmarking assesses performance by building and by total school district, utilizing 12-month meter data, building information, the U.S. EPA Portfolio Manager, and our own database and analytics. We also developed methods to use the results to motivate and empower school administrators to reduce energy use. Some conclusions confirm expectations and others are surprising. The data set is large enough to be meaningful and includes school districts large and small (1 to 290 campuses), rural and urban, and in significantly varied political/economic locales. In narrative and graphical form, this paper discusses results and conclusions that may be useful to program managers in other jurisdictions, for example:

- There is very wide disparity of energy performance in K-12 schools – the highest energy-consuming schools may use up to seven times more energy per square foot than the lowest energy consuming schools – even within the same climate zone. Excluding the most extreme buildings, the range is about three-fold.
- On average, newer schools use about the same amount of energy per square foot as older schools. Although the building and equipment efficiency may be better, additional energy loads (e.g., more outside air or high energy-consuming spaces like theaters) often more than replace the efficiency gains.
- There is a measurable difference in energy use in areas with high humidity, even where degree-days are similar.
- There is some correlation of better building energy usage and the relative wealth (available budgets) of school districts.
- The U.S. EPA Portfolio Manager Score aligns with energy consumption per square foot in most, but not all cases.
- Although there is general uniformity in building space utilization, occupant density can vary widely, translating to a correspondingly wide range in energy cost per student.
- Elementary and middle schools (grades K-8) both use a similar amount of energy per square foot. High schools (grades 9-12) use more, but not as much as energy managers tend to expect (about 8% more on average).
- Most school administrators and energy managers do not have a clear understanding of how the performance of their buildings compares to others; therefore, benchmarking is a very effective tool to help motivate administrators, break down departmental silos, improve decision-making, and accelerate project funding.

Background

Since late 2005, CLEAResult Consulting has implemented the Schools Conserving Resources (SCORE) Program in Texas for AEP SWEPCO, AEP-Texas Central, AEP-Texas North, TXU Electric Delivery/Oncor, and CenterPoint Energy. Since early 2007, CLEAResult has implemented the Sure Bet for Schools Program for Nevada Power and Sierra Pacific Power. The core objective of all of these initiatives is to encourage and assist public K-12 schools to use energy more efficiently, within the constraints and budget limitations that many school districts face. This paper discusses the benchmarking in both Nevada and Texas.

Building Performance Benchmarking is one of several tools that CLEAResult provides for schools. Though the additional portfolio of tools is beyond the discussion of this paper, it may interest the reader to know that SCORE and Sure Bet also help school district managers to benchmark their energy management practices, help prepare an *Energy Master Plan*, conduct workshops covering topics such as advanced building technologies, and provide guidance for building improvements. In combination, these programs to date have assisted over 75 school districts to reduce energy demand and consumption cost-effectively.

This is not the first paper presented at the ACEEE Summer Study to discuss the value of energy benchmarking in public schools. In 1998, Terry Sharp presented the results of an assessment of CBECS data for schools. In 2006, Gregory Coleman and Matthew Brown presented results from benchmarking about 500 schools in New York. CLEAResult developed the benchmarking process discussed in this paper in part based on the valuable experience of the previous authors. However, the approach of this paper is different in several ways. First, the data set is substantially larger than the number of schools discussed in the Sharp and Coleman/Brown papers. Second, this paper focuses on discussing measured patterns in energy use among the schools in contrast to many school administrators' common perceptions about energy use. Finally, this paper emphasizes that a benchmarking process similar to this can be a powerful tool to empower and inform school administrators to approach energy management planning in a different way than they would have without it.

The Challenge

Energy expenditures are a significant cost for public schools – usually the second largest budget category after salaries. Despite this, many school districts do not have the technical, managerial, or capital resources to manage energy costs as proactively as they should. Although there are some exceptions, we have found this challenge to be widespread – affecting over two-thirds of the school districts with whom we have worked. It is particularly acute – nearly 100% – for smaller districts that spend less than $2,000,000 a year on energy and who are very unlikely to have an energy manager on staff. Even in districts with full time energy managers, the individual may have limited experience with efficiency technologies and techniques and may not have the standing within the district to implement changes or get the investments needed to improve the energy performance of the district buildings.

Within this context, CLEAResult, on behalf of the electric utilities listed above, investigated the causes that both create and perpetuate these circumstances. Through interviews with administrators at dozens of school districts, we identified a variety of drivers. One of the most common and most significant drivers to ineffective decision-making regarding energy efficiency improvements is that most school administrators do not have a clear understanding of

how the energy performance of their buildings compares to other school buildings – both within and outside the district. As a result, CLEAResult developed a process to provide the benchmarking discussed below.

Our Approach

As part of the SCORE (Schools Conserving Resources) Program for Texas utilities and Sure Bet for Schools Program for Nevada utilities, we collect building energy consumption data (12 months of utility bills) and building characteristic data (e.g., size, occupants, plug loads) and compare relevant metrics using both the U.S. EPA Portfolio Manager and our own database. CLEAResult built the benchmarking tool, in part, on the excellent previous work done by NYSERDA and EPA. Although benchmarking is not the only service we provide, it is typically the first step because it clarifies and focuses the need to take other actions. We present the benchmarking results to senior school district managers as a springboard for action toward planning further efforts and assessing individual building opportunities.

The benchmarking report we provide to school districts describes the benchmarking process, provides an overview of how to interpret and apply the results, and includes several graphical comparisons. We provide a benchmark graph for each building/campus, which compares each school with other schools in the region according to annual site energy used (kBtu/sq.ft.), energy cost per square foot ($/sq.ft.), and energy cost per student ($/student). District managers helped us determine that these metrics are the most useful to them. In the same report, we also provide a score from the U.S. EPA Portfolio Manager tool, which we run for them. This provides a separate comparison of how the EPA tool rates the building performance nationally.

As we have learned more about school district operations and the value of benchmarking, we have continuously evolved the benchmarking process, including the data analyses, the content of the report, and the methods we use to present it.

Observations

By using benchmarking to guide better energy management and planning, we have observed that school administrators have a number of perceptions about energy use that often have a substantial impact on how they view their need to invest in energy efficiency improvements. The benchmarking clarifies or corrects these perceptions. Below we describe eight of these perceptions and the observations we can make based on the 1,775 schools benchmarked to date.

Observation #1

Perception: School administrators and facility/energy managers generally understand their energy consumption needs, costs, and patterns.

Reality: The results of the benchmarking are often quite eye opening to school administrators. Under these programs, benchmarking reports have been prepared and presented to over 60 school districts. We present the reports in printed form in face-to-face meetings. School administrators have consistently expressed that the reports provide a much better understanding about their energy consumptions than they had before. This is the most important value derived

from the process. Very seldom have we observed that the benchmarking results confirmed the efficiency levels that managers previously expected. Most often, the results are surprising. Before benchmarking, many managers predict how efficiently they are operating their buildings based primarily on how much effort or investment they have made, without any actual measurement of comparative results. Not all school administrators are happy with the benchmarking results and some initially question the accuracy. In all cases, however, the program implementers work to verify that the collected data is accurate and complete and that the reports correctly describe the energy performance of the buildings.

Starting with the review of the benchmarking report, the program implementers encourage an in-depth discussion with facilities, financial, and other departments about building operations, energy efficiency investments, new building design, operational methods, and planning. In all but a few cases, we have found that this detailed discussion had never happened previously. One objective of the programs is to use this discussion as a starting point to accelerate investments in energy efficiency improvements. It has been very effective in accomplishing this as nearly all of the benchmarked school districts have subsequently begun making efficiency improvements within a year. Several school districts have invested millions of dollars in efficiency improvement projects – which were not previously planned – within months of the presentation of the benchmarking results. Although the programs do not track specific comments, a number of school superintendents and facility managers have expressed to program implementers and program evaluators that the benchmarking results created compelling urgency and documentation to encourage efficiency investments. We have not evaluated the role of benchmarking separately from other program activities (e.g., energy master planning, technical assistance, and cash incentives); however, program managers believe benchmarking plays a pivotal role.

Below we present two examples of a benchmarking report graph, one for a high performing school, shown in Figure 1a, and a lower performing, school shown in Figure 1b. The upper left side of the report for each campus compares the annual energy use (kBtu/sq.ft.), the annual energy cost per square foot ($/sq.ft.) and the annual energy cost per student ($/student) to the average for the region. We also provide the EPA Portfolio Manager score. The upper right side graphically depicts the ranking of the benchmarks and the lower half of the page shows the data used to develop the report (excluding the utility bill data, which is for 12 months and may include many meters).

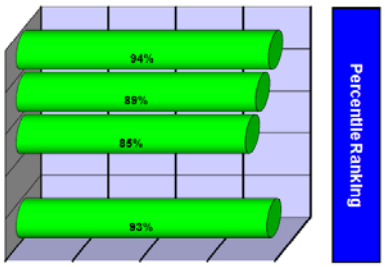
Figure 1a. Benchmarking Report for a High Performing School

Energy Performance Benchmarking Analysis

High Performing School

Local Texas Benchmarks	TX Average*	Your School
Annual Energy Use (kBtu/sq.ft.)	46.4	30.8
Annual Energy Cost ($/sq.ft.)	$1.20	$0.81
Annual Energy Cost ($/student)	$157	$100
National Benchmark	**National Average**	**Your School**
U.S. EPA Portfolio Manager Score	50	93

* Average for schools in similar climate regions of the state.



(Higher percentiles indicate lower energy use / lower costs)

Building Characteristics		Energy Use/Cost Data	
Year Built	2002	Beginning Billing Month	January-07
Floor Area (sq. ft.)	70,400	Ending Billing Month	December-07
Number of Students	571	Electricity Usage (KWh)	464,940
Number of PCs	125	Electricity Cost ($)	$51,616
Type of Heating System	Gas Heating Only	Natural Gas Usage (therms)	5,797
Weekly Operating Hours	50	Natural Gas Cost ($)	$5,358
		Total Energy Cost ($)	$56,975

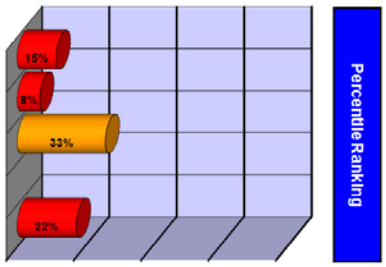
Figure 1b. Benchmarking Report for a Low Performing School.

Energy Performance Benchmarking Analysis

Low Performing School

Local Texas Benchmarks	TX Average*	Your School
Annual Energy Use (kBtu/sq.ft.)	46.4	65.6
Annual Energy Cost ($/sq.ft.)	$1.20	$1.91
Annual Energy Cost ($/student)	$157	$190
National Benchmark	**National Average**	**Your School**
U.S. EPA Portfolio Manager Score	50	22

* Average for schools in similar climate regions of the state.



(Higher percentiles indicate lower energy use / lower costs)

Building Characteristics		Energy Use/Cost Data	
Year Built	1960	Beginning Billing Month	August-06
Floor Area (sq. ft.)	44,026	Ending Billing Month	July-07
Number of Students	444	Electricity Usage (KWh)	687,520
Number of PCs	163	Electricity Cost ($)	$79,177
Type of Heating System	Gas Heating Only	Natural Gas Usage (therms)	5,439
Weekly Operating Hours	55	Natural Gas Cost ($)	$5,056
		Total Energy Cost ($)	$84,233

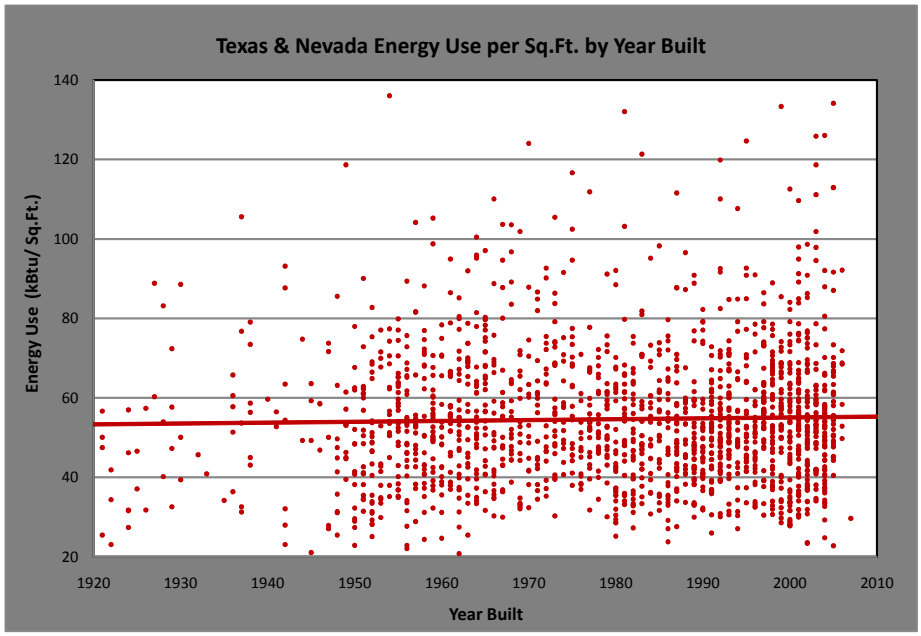
Observation #2

Perception: Newer school buildings are more efficient and use less energy per square foot than older schools.

Reality: On average, newer schools do not use less energy. This is a surprise to most school administrators. Their perception is that if they have newer buildings, they are using less energy per square foot than other districts with older buildings, or their own older buildings. Although newer buildings may have more efficient HVAC equipment, lighting, or building envelope characteristics, other factors such as fresh air ventilation rates, computer and video equipment, or special features such as natatoriums or performance theaters may offset the efficiency gains.

Figure 2 charts about 1,775 schools, comparing the total energy consumption (y-axis) and the year the building was originally built (x-axis). The scatter distribution and linear regression demonstrate that there is no proof that newer schools use less energy. There are many other factors that can affect this pattern that are not shown in this graph (such as major renovations), but the data nevertheless argues against the general perception that newer buildings are more energy efficient. Note that many of the linear regressions shown in this paper have low R squared values, but the lines are included to give a useful visual rendering of the average values of the data sets we are comparing.

Figure 2. Comparison of Energy Use by Year Built

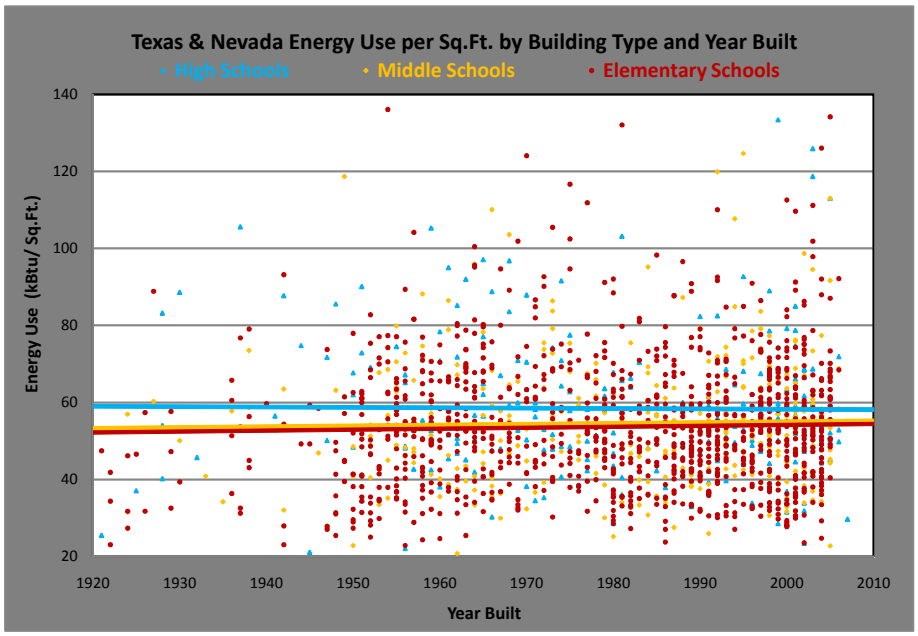


Observation #3

Perception: High schools use much more energy per square foot than elementary and middle schools.

Reality: Although many school administrators perceive that energy use in high schools is much higher (>30%), benchmarking shows that this is not correct. Although we have found that high schools generally use slightly more energy, the amount is substantially less than most energy managers expect - only about 8% more. The graph below shows both the distribution and trend lines of energy use by school type.

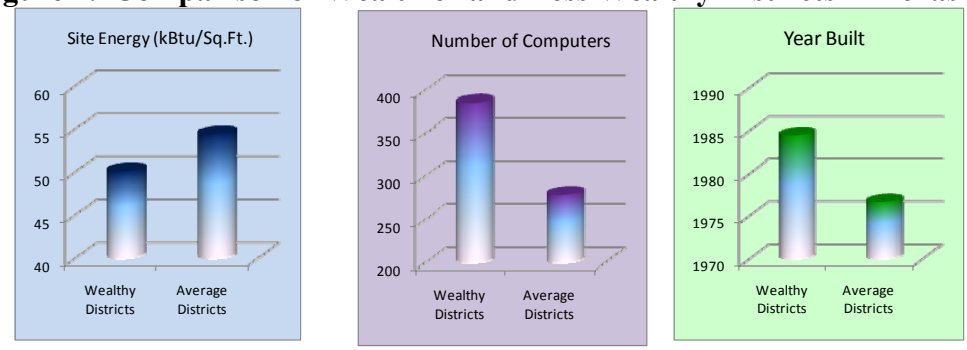
Figure 3. Comparison of Energy Use by School Type



Observation #4

Perception: Wealthier districts, with more available funds for efficient school construction and improvement projects, typically have buildings that are more efficient and use less energy.
Reality: Our determination of which districts are "wealthier" is somewhat subjective, but generally, we have found this to be true. Contrary to patterns in other groups, we observe that "wealthier" districts have newer buildings and more computers, yet use less energy. Figure 4 shows a comparison of "wealthier" Texas districts to average Texas districts for energy use, number of computers, and the average of the year the schools were built.

Figure 4. Comparison of Wealthier and Less Wealthy Districts in Texas

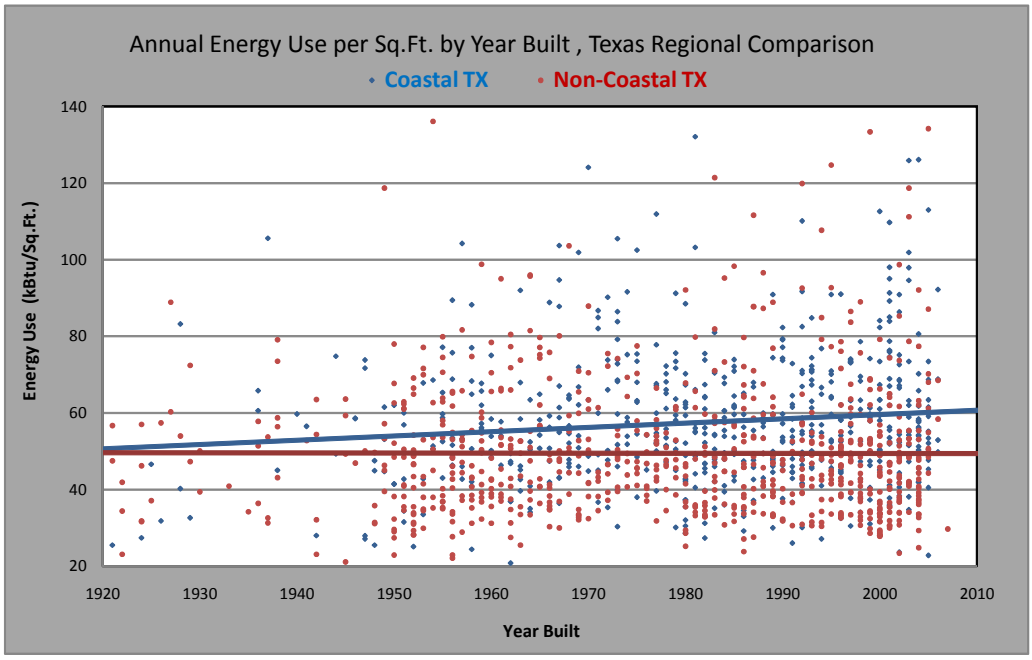


Observation #5

Perception: Higher average relative humidity of the area in which the schools are located drives up energy consumption and costs – even when degree-days are similar or slightly lower.

Reality: Our data suggests this is true. Relative humidity is often not considered in benchmarking tools, even when the methods are climate adjusted and weather normalized. Because of the large number of schools we have benchmarked throughout Texas, we are able to compare energy consumption in humid, coastal Texas to drier, inland Texas. Although other factors could explain the differences, our separate assessments of individual district energy management practices and individual schools has led us to conclude that the single largest driver in these differences is the higher humidity and subsequently higher cooling loads. Figure 5 shows over 1,300 schools we have benchmarked in Texas, separating the schools in the more humid coastal areas (blue) and less humid non-coastal areas (red).

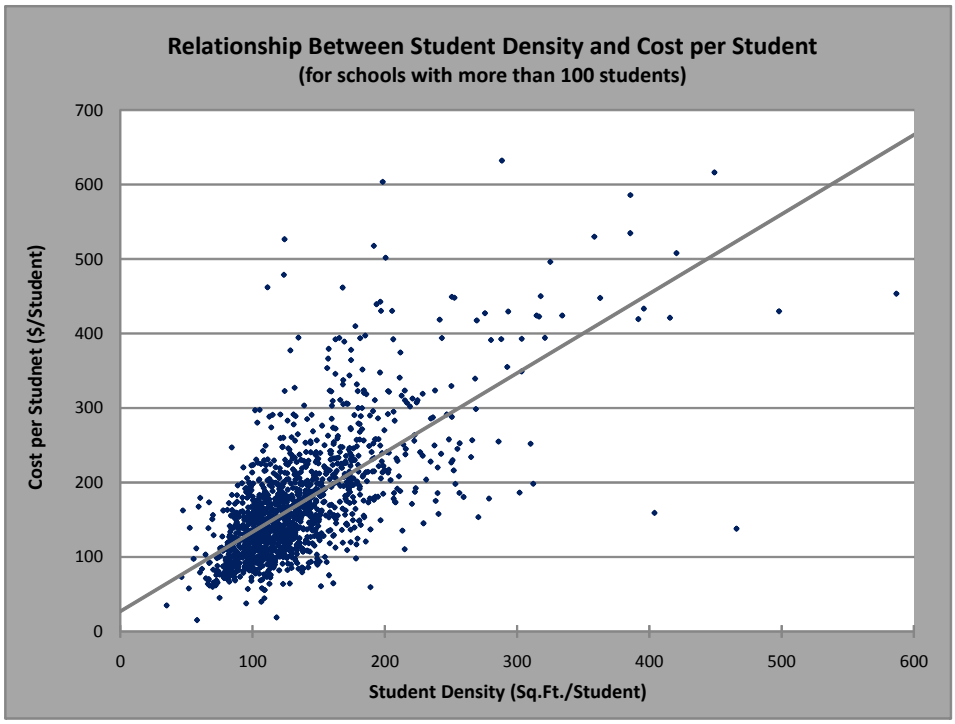
Figure 5. Comparison of Energy Use in Coastal and Non-Coastal Texas



Observation #6

Perception: Building space utilization (i.e., student density in sq.ft. per student) is uniform among K-12 schools and, therefore, has little impact on energy cost per student.
Reality: Energy cost per student is a useful metric for many school district administrators. However, if not considered, variations in space utilization can skew benchmarks for building performance. As Figure 6 shows, most schools we benchmarked in Texas (71%) have an actual student density between 75-200 square feet per student and a cost of $75-$200 per student per year. The other 29% of schools, however, can vary widely in sq.ft./student, energy cost/student, or both. This information can be valuable to help school administrators understand their energy use and how building utilization may affect it.

Figure 6. Comparison of Energy Cost per Student and Student Density in Texas

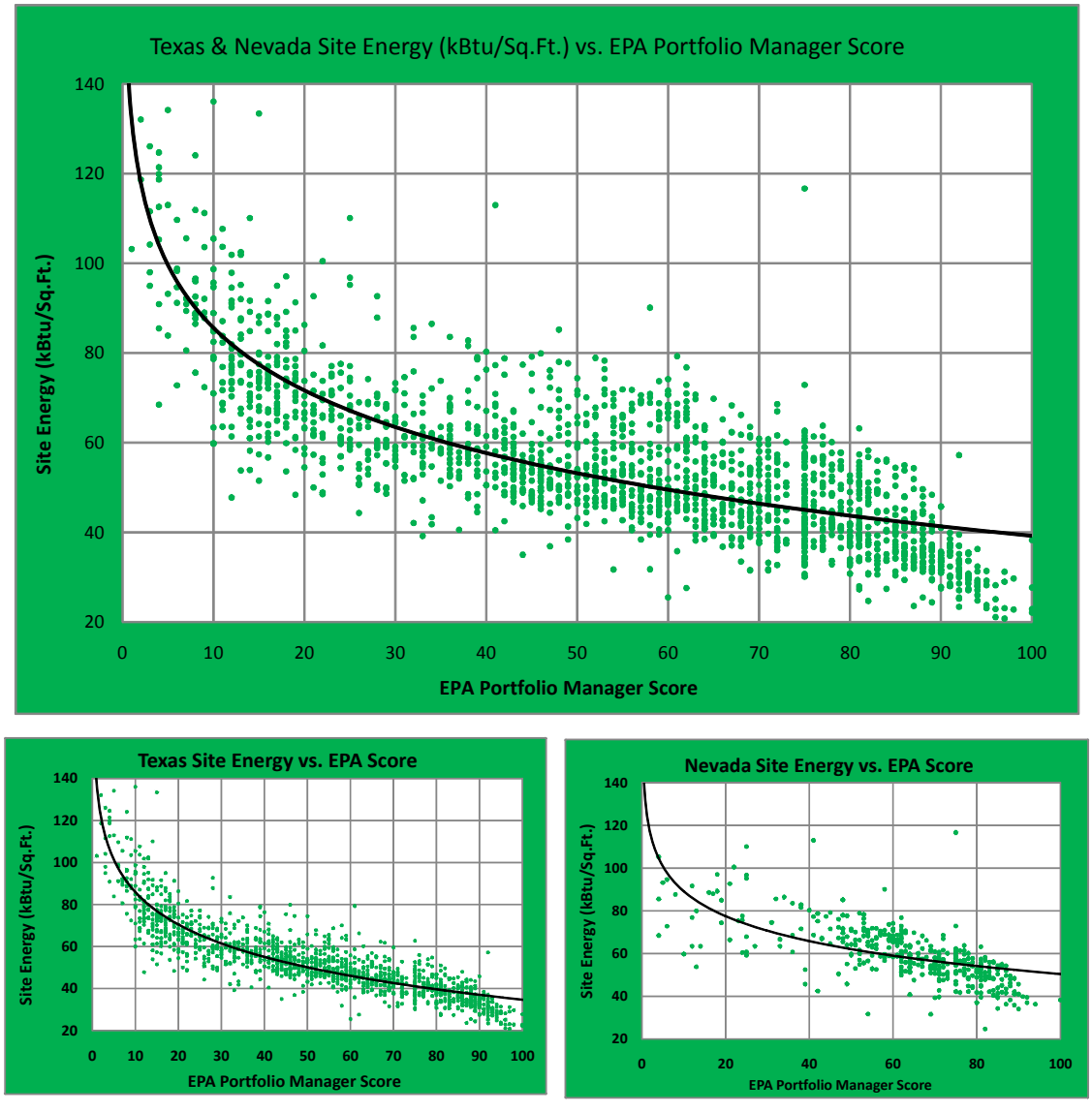


Observation #7

Perception: The U.S. EPA Portfolio Manger score aligns closely to the other benchmarking metrics.

Reality: *Overall*, the EPA Portfolio Manager score does correlate well with the annual energy use benchmarks as shown in Figure 7 (and also with cost/sq.ft and cost/student, not shown). When considering individual schools, however, the difference between the EPA Score and the regional benchmark can be significant. While neither benchmark may be perfect, we have found that using a combination of the two methods is more compelling than using either alone. The graphs in Figure 7 show a comparison of the Site Energy Use (kBtu/Sq.ft.) to the EPA Score for all the schools benchmarked to date, and for the schools in Texas and Nevada separately.

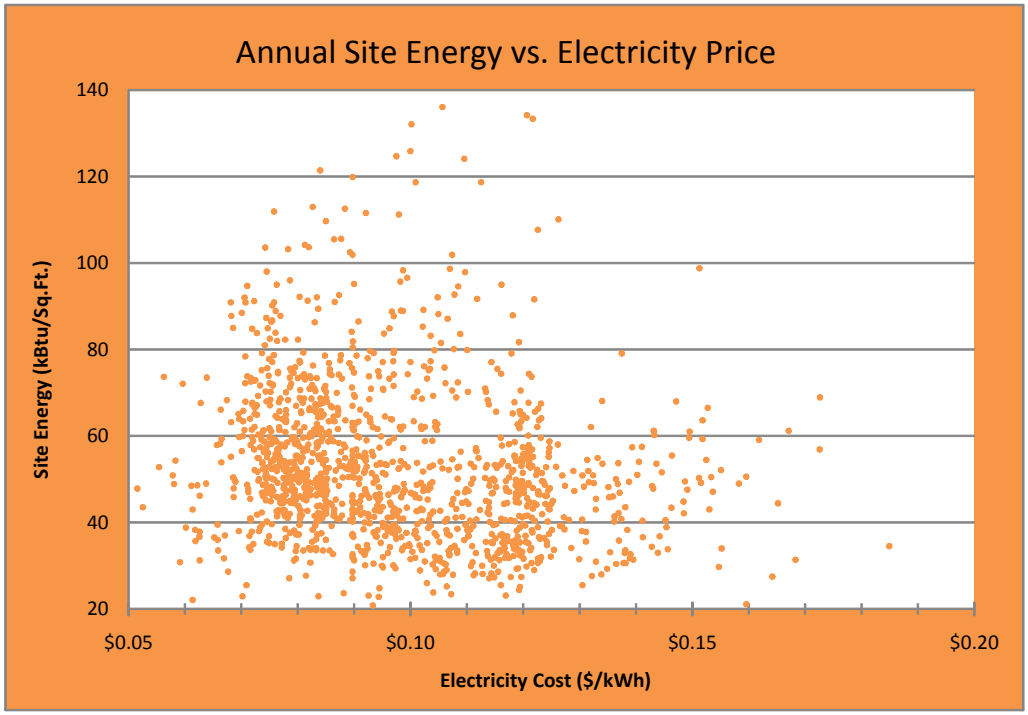
Figure 7. Comparison of Annual Energy Use and EPA Portfolio Manager Score



Observation #8

Perception: As energy rates increase, building managers become more motivated, more diligent, and more successful in reducing energy consumption.
Reality: We can neither prove nor disprove this perception with the school building data we have benchmarked *overall,* in part because it would require data from both before and after rate increases became effective. Moreover, there may be a time lag from the date a rate increase becomes effective and the date energy improvements are completed and begin yielding results. Nevertheless, the information regarding energy use and electricity rates shown in Figure 8 below can be very compelling to school energy managers because they can look not just at the overall distribution, but also at the location on the graph of *individual* schools, which may identify buildings that deserve attention. The overall distribution for Texas schools is provided in Figure 8 below.

Figure 8. Energy Rates and Energy Density



Summary

Most public school administrators and energy managers do not have access to the needed information to evaluate and compare the energy performance of their school buildings. This can be a costly shortcoming, since energy costs are usually the second largest budget expense for school districts. By comparing energy use and other building characteristics between schools within a district and to schools in other districts, administrators can better understand their energy profile and costs. In the SCORE and Sure Bet for Schools programs in Texas and Nevada, respectively, program implementers have found that providing benchmarking information to districts is a very powerful and compelling first step in helping them identify,

prioritize, plan, fund, and implement energy efficiency projects. In many cases, it resulted in an immediate acceleration of investments in energy-efficiency improvement projects. Other tools and guidance are needed beyond benchmarking, though benchmarking provides the initial catalyst to motivate other actions and help to overcome misperceptions that have often impeded action or perpetuated inaction. Utilities and program implementers that provide these kinds of tools to their customers can offer an important service that generally is not available to most school administrators and decision-makers.

References

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Coleman, Gregory & Brown, Matthew. 2006. "Program Design & Implementation: Targeting New York State K-12 Schools." In *Proceedings of the ACEEE 2006 Summer Study on Energy Efficiency in Buildings*. 4:38-49. Pacific Grove, CA: American Council for an Energy-Efficient Economy.