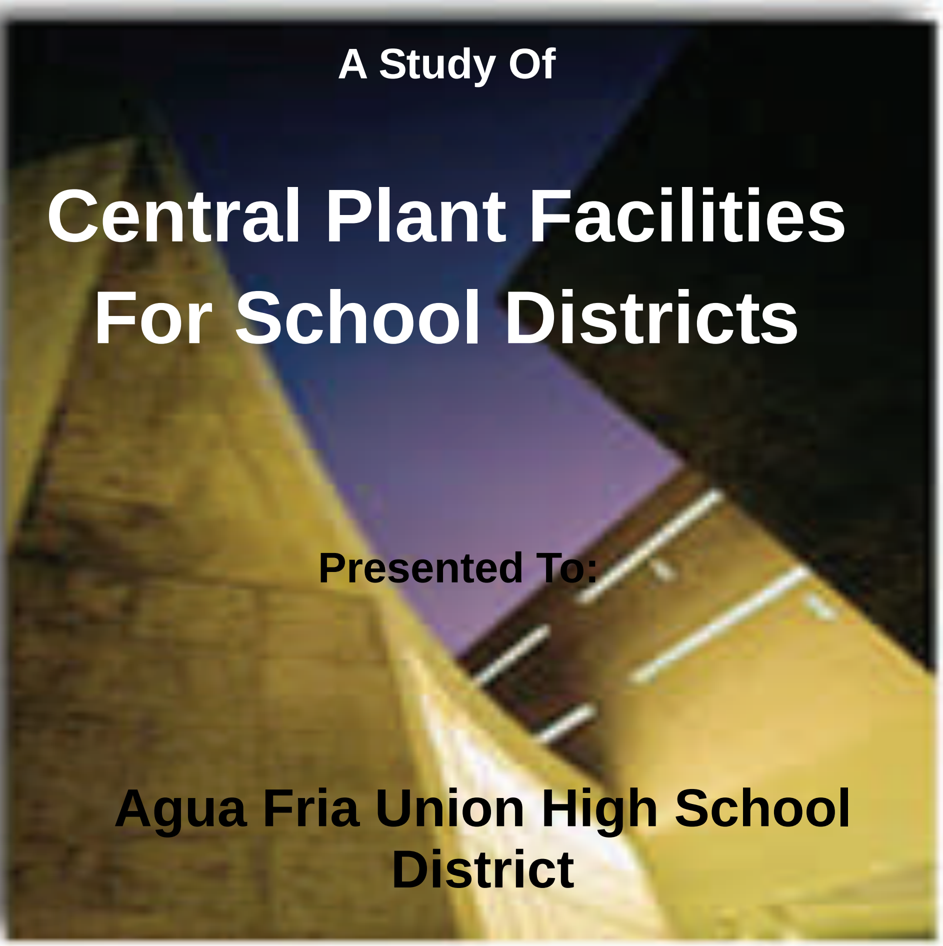
The Efficacy of Outsourced Commodities



A Study Of

Central Plant Facilities For School Districts

Presented To:

Agua Fria Union High School District

GOLDEN STATE ENERGY

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Preface

This study was commissioned by the Agua Fria Union High School District to examine energy issues as they relate to greater operating efficiencies, including an analysis of the Districts use of a central plant approach of district heating and cooling. Included in this study is the comparison of the Tolleson Union High School District campus which uses a packaged HVAC system exclusively. And finally, this study analyzes Outsourced Commodity as an alternative to owning, operating, and maintaining the districts boilers and HVAC equipment.

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EXECUTIVE SUMMARY

School facilities are extremely capital-intensive investments that require continuous professional oversight and maintenance. Administrators must ensure the best long-term returns both operationally, and more importantly, contributing to an improved classroom environment. Faced with dwindling funds and few other options, the administrators at Agua Fria Union High School District decided to do something proactive about delivery of a guaranteed long term high-quality learning environment for their student population. The District worked collaboratively with industry experts on a creatively-structured transaction, eliminating the need for financing of operations and maintenance, and the installation of a more efficient central plant facility. The outsourcing methodology implemented is commonly used by the utility, commercial, manufacturing industry to save on scarce financial resources, but was modified to meet the special needs of the School District.

Under this program, the District is the end user of cooling and heating supplied by a private utility. This program addresses the current and future needs of the District under a fixed tariff for cooling and heating. By comparing Agua Fria Union High School District with Tolleson Union High School District, this review concludes the following:

1. The program not only yields energy and operational savings of over $500,000 on an annual basis, but also saved the District the investment of $2.5 million of capital. This avoided capital cost eliminates some $300,000 of annual bond repayments, and more importantly does not impact the District's bond ratings.
2. The program provides detailed continuous monitoring to track cooling and heating usage while optimizing the energy usage all year round.
3. The program focuses the District on the facilities educational and environmental requirements, and gets them out of the air conditioning business.
4. The program lets the District benefit from professional service, enhanced system management through long term predictability, eliminating costly breakdowns, repairs and boosts system reliability
5. The program provide continuous real time management of Indoor Air Quality by keeping CO_2 levels at or below the required amounts specified by ASHRAE 90.1-1999, matching fresh air needs directly to real-time occupancy, while minimizing energy use.
6. The program provides a mechanism to address all future heating, cooling, and energy needs as the district expands its square footage, without using bond funds.
7. The program frees up existing district personnel to be more productive at their core competencies and other deferred areas of need.
8. The program eliminates the common practice of lowest first cost, poor workmanship, and high operating costs.
9. The program maintains long-term system performance thus, eliminating the need for long term bond monies to pay for short lived energy assets.

The detailed energy/usage/cost information available at the Agua Fria High School District was not mirrored at the Tolleson School District, so certain assumptions on operating usage and capacities were used in the comparison of the two school districts.

The Agua Fria High School District won the coveted Governors Award for Energy Efficiency became the spark to focus more on the energy element of their operations. The outsourcing program helps them accomplish this and more. It is ideal for school districts who want to refocus on their core competencies of overseeing and administering the educational process. It frees up and provides funds normally used for operations and maintenance, and capital improvements of the energy infrastructure. The administration and bottom line thinkers at the Agua Fria Union High School District outsource to specialists to deliver a commodity far more efficiently, ultimately delivering a better environment more efficiently and at a lower cost.

The Efficacy of Outsourced Commodities
Agua Fria Union High School District

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Golden State Energy

Introduction

Learning institutions are the cornerstones to the life of local communities and to society itself. Around the country, about twenty percent (20%) of the population spend their days in school buildings. According to the National Center for Education Statistics, it is estimated that the number of students attending K-12 schools in the United States during the school year 2004 – 2005 is 54,455,000.

Yet when you look around, it becomes evident that this critical component of our national infrastructure is crumbling. Every state has school buildings which have environmental problems that adversely affect the health, productivity, and well-being of those students and staff we are tying to educate.

Schools are facing rapidly changing and increasingly complex educational and technological challenges. The complexity of learning in today's classrooms, the need for constant improvement in student achievement, and the inevitable steady advance of environmental technologies are conditions that require core competencies in too many functional areas. The educational climate today demands that schools adapt to keep up with these changes.

The core operations of school district energy systems are atypical places to maintain, especially for facilities management personnel. Where else would someone be responsible for making sure dozens of 19th-century buildings and Quonset huts keep working well, while overseeing the construction of several new buildings? Then what about the haphazard mix of equipment ranging from chilled water systems, packaged rooftop units, cogeneration plants, hot water heaters, boilers, and even low first cost window air conditioners used in many cases due to budget constraints? It is at once evident that there is no cohesive plan looking to the future cost of M&O of those buildings. Traditionally, on-the-job-trained facilities management employees have kept this diverse mix of buildings and systems working as best they can with limited M&O budgets. For the facility operators, complacency developed a deep set of roots in the learning halls of our country.

In many cases, janitors have replaced the facilities personnel because of budget woes. Responses to service-requests are often delayed while floors are swept and the trash taken out. Customer service oriented administrators become frustrated to see their once proud centers of learning crumble due to the lack of funds for infrastructure operations and maintenance. Yet these same under-trained over-worked employees are one of the many reasons why some academic institutions are looking to outsourcing as a possible solution.

The Problem

The American Society of Civil Engineers (ASCE) reports that 75 percent of our nation's school buildings remain inadequate to meet the needs of our school children. They believe rebuilding America's schools is another area worthy of close attention of Congress. One-third of our schools need extensive repair or replacement. Where appropriate, the federal government should assist local and state governments with this enormous task. The price tag, according to the ASCE report, is about $112 billion to repair, renovate, and modernize our schools and another $60 billion to construct new schools to accommodate the 3 million new students expected in the next decade.

In 1999, the Department of Education issued a report titled <u>Condition of America's Public Schools</u>. In the report they stated that 64 percent of Arizona's schools have at least one inadequate building feature. Additionally 69 percent of Arizona's schools have at least one unsatisfactory environmental condition. [2]

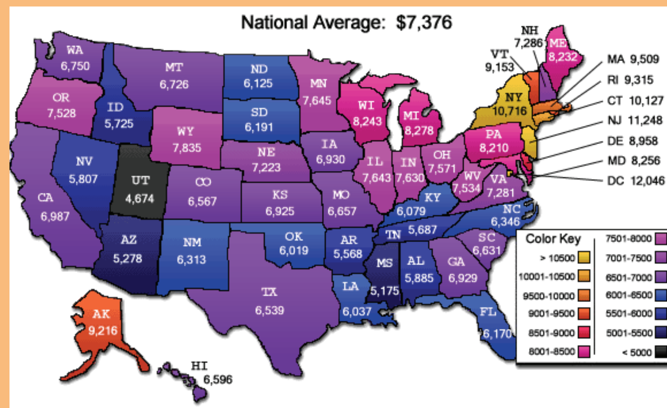
> "We cannot solve the problems we have created with the same thinking that created them"—Albert Einstein

1) National Center for Education Statistics, "Projection of Education Statistics until 2013"
2) Condition of America's Public Schools, 1999, Dept of Education

The Arizona School Facilities Board approved construction contracts, meeting a legislative deadline for the $1.28 billion program to award all but a handful of projects in three districts. The board has undertaken more than 5,500 school repair projects since the first 150 emergency jobs were done in 1999 – 2000. The rest of the work was not launched until May 2001, and most is now finished. For the past several years, the program's costly demands on the general fund have worsened the Legislature's budget-balancing problems. Yet, it has been largely outside of lawmaker's budgetary control because it was established in direct response to a court order designed to force the equitable financing statewide of public school facilities.[3]

Per-Pupil Expenditures

Elementary & Secondary Schools
School Year 2000-2001



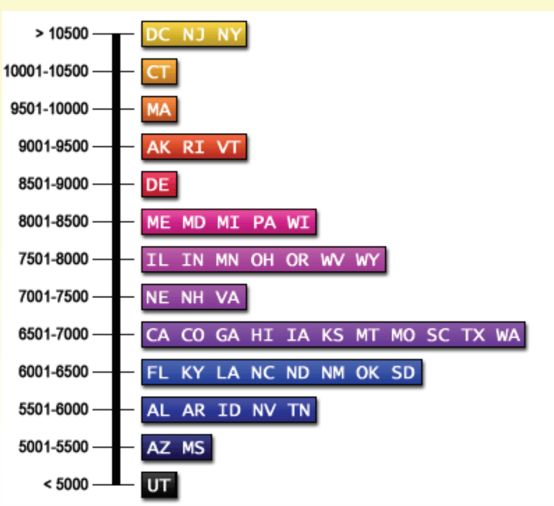
NOTE: Current expenditures include salaries, employee benefits, purchased services, and supplies, but exclude capital outlay, debt service, facilities acquisition and construction, and equipment.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Common Core Data, "National Public Education Financial Survey"

Figure 1

". . .Arizona 49th in per pupil expenditures among the fifty states. . ."

Per-Pupil Expenditures
Elementary & Secondary Schools 2000-2001



SOURCE: U.S. Department of Education, National Center for Education Statistics

Figure 2

NOTE: Current expenditures include salaries, employee benefits, purchased services, and supplies, but exclude capital outlay, debt service, facilities acquisition and construction, and equipment. Dollar amounts for states and the District of Columbia were grouped in $500 ranges (e.g. $8501-$9000).

Under Funded Schools in Arizona

There is an unexplained phenomena occurring in the funding of Arizona schools. While the intention may be good, like minimizing the tax rate, there are unintended consequences and the end result is devastating for the school system. Due to some unseen geopolitical force the school districts of Arizona have been experiencing many years of inadequate funding which has been lamented as the culprit for many of their educational woes. To compound the problem, there has been an explosive growth in student population. From 1991 to 2001 the student count nationwide increased thirteen (13%) percent, while Arizona increased 38 percent. Only 16 states had more total students in 2001 than Arizona. According to the Public Instruction's annual report, only 3.1% of district M&O revenues were from the federal government while 61.1% was from state aid.

Arizona has been in the bottom five of the 50 states in terms of per pupil expenditure for the past ten years. In a climate of low funding for public schools during the 1990s, the Arizona legislature enacted a variety of laws and provisions. They expanded charter schools, created a tax credit for taxpayers who contribute money to be used for private school scholarships, assumed responsibility for school construction costs, increased sales taxes through a citizen's initiative to increase school funding, and sought to use Indian gaming revenues to add to support for schools.

The National Center for Education Statistics (NCES) ranked Arizona 49th in per pupil expenditures among the fifty states in its latest report "Early Estimates of Public Elementary and Secondary Education Statistics: School Year 2001-2002". Arizona has ranked at, or near the bottom of most states in the

3) The Arizona Republic, July 2, 2003

nation every year since 1997 per student funding. In contrast, as mentioned, during 1987 Arizona ranked 31st in the nation.

Excess Utilities

The root of one of the problems is that Arizona's school funding formula is over two decades old and is acutely in need of a bottom-up revision. It seems that, aside from being incomprehensible, convoluted, and difficult for the average taxpayer to understand, it distinctly lacks depth in providing funds for school districts to cover routine costs. To compound the problem, a formula interlaced with a series of overrides appears to hide the true cost of operating a school district. Consequently, it appears that there is a fundamental imbalance of a public accounting as to where the tax dollar is spent.

The taxpayer has spoken through Proposition 301 removing the excess utilities component of the school funding system. However, it won't be phased out until 2009. School districts will need to radically adjust to the changing environment since they have come to rely heavily on excess utilities to cover M&O costs.

Arizona has established incentives for school districts to reduce their utility costs. If they are able to reduce the excess utility costs, the district may use one half of the savings to reduce the property tax in the district and the other half to increase the districts general budget limit.[4] This expressly excludes capital expenditures on energy equipment and may change when the excess utilities is phased out.

The Agua Fria District Background

The Agua Fria Union High School was first built in 1955, is located west of Phoenix in the Cities of Avondale, Goodyear, Litchfield Park, and unincorporated Maricopa County, Arizona. The District is 98 square miles with a population of about 85,000.

The District comprises of three high schools inclusive of Agua Fria, Millennium, and Desert Edge; the newest of the schools. The Agua Fria campus has nearly 242,000 square feet of conditioned space with a student body of over 1,740 students. The Millennium campus has 196,485 square feet with 1,680 students attending classes. Finally, the newest high school in the District is Desert Edge which has 127,403 square feet of conditioned space with about 850 students.

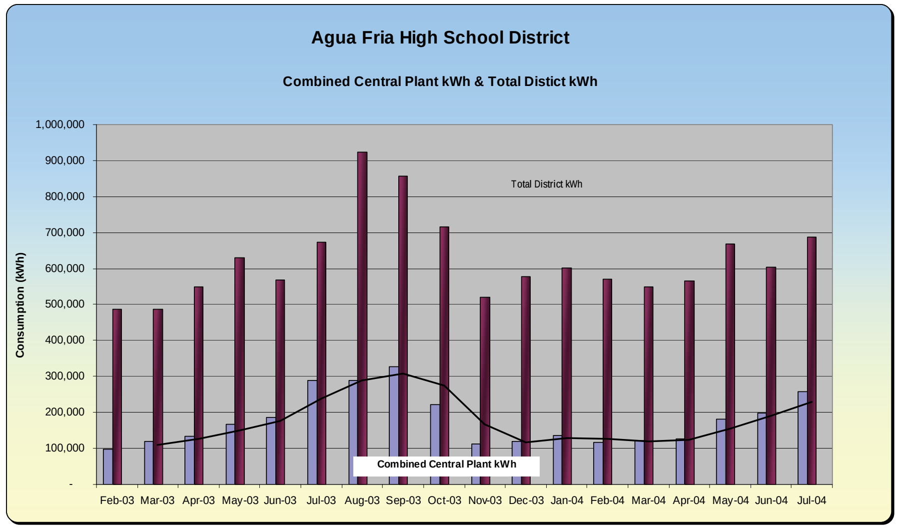


Figure 3

The District currently has a student body of approximately 4,250 students which has experienced a tremendous influx of students over the last number of years. This has forced the expansion of all campuses, to the point of expanding into and building a new Desert Edge high school. They are already adding another 90,000 square feet to Desert Edge for a projected 1,600 students. There is a 4th Verrado High School now in design. It is the first school in Arizona being designed under the LEED standard. More on this subject later in this report.

A map of the entire district and each of the high school boundaries can be found in Appendix A-1.

District Energy Use

The Agua Fria School Districts electricity provider is Arizona Public Service (APS). Southwest Gas Corporation provides the natural gas for the District. Although energy use varies seasonally, the total connected load for each of the high schools is about one megawatt. Agua Fria High School uses about 3,190,000 kilowatt hours (kWh) each year and averages about 265,000 kWh per month (Appendix B-1). This chart shows the kilowatt demand and square footage increases from January 1998 to current.

> *"A resource-efficient school minimizes the use of resources in building construction and over the operating life of the building. It also ensures that your building occupants will have a high quality environment that promotes health and productivity."*
>
> **SOURCE:** *Washington State University Cooperative Extension Energy Program*

4) A.R.S §15-910.02(A), (C), (E)

Millenium High School uses about 2,983,000 kWh each year with an average of about 248,500 kWh per month (Appendix B-1). This chart illustrates the kilowatt demand and square footage increases from February 1998 to current.

Desert Edge High School uses about 1,670,000 kWh annually with an average of about 139,000 kWh per month (Appendix B-2). This chart illustrates the kilowatt demand and the square footage increases from December 2001 to current. This is the newest school which, with the increase in student population will become the most energy efficient of the schools at the District.

Combined, the district uses nearly 8.0 million kWh each year with an average bundled rate at $0.0744 per kWh resulting in an electricity cost of almost $666,000. Details of each high school can be found in Appendix D-1 through D-4. A comparison of the square footage of each high school as the school added square footage, and the electric demand was overlaid in a graph found in Appendix B-1. Although the district has added about 1,000 students and increased the square footage since 2002, the kilowatt demand and Btu's per square foot has either remained the same or decreased slightly. This is a significant achievement for the district. Typically there is a linear correlation between an increase in students, square footage, and energy use.

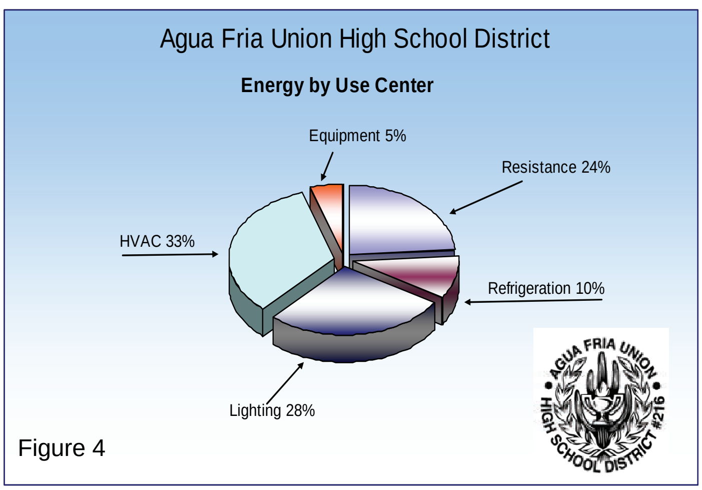


Figure 4

Energy by Use Center

To illustrate where energy expenditures directly impact schools, according to the Alliance to Save Energy school districts pay more for their energy use than they do for textbooks and computers combined. Computers however have a major impact on energy use not only powering the computer, but creating a tremendous heat load that is cooled through the HVAC system.

The U.S. Department of Energy stresses that utility costs are second only to payroll. They also stress that when considering building design, HVAC equipment and energy-based systems decisions should be based on life cycle analysis.

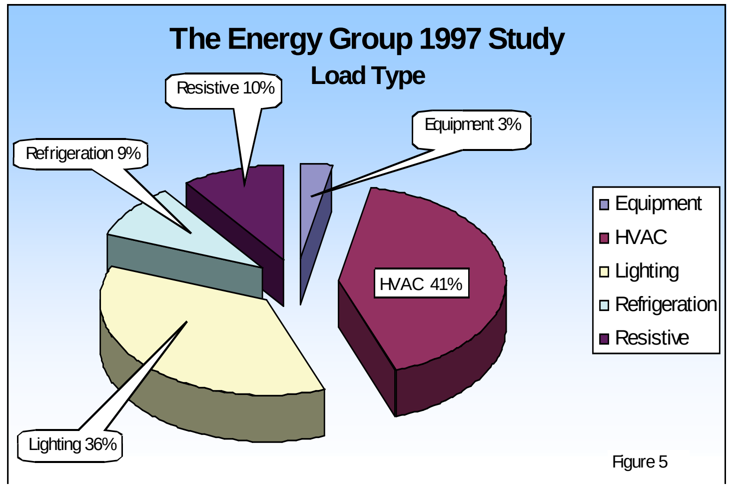


Figure 5

"school districts pay more for their energy use than they do for textbooks and computers combined."

Source: Alliance to Save Energy

The age-old axiom "You can't manage what you can't measure" is used when referring to the need for utility metering and monitoring capabilities. A literal translation of the phrase would be: "You can't manage energy *if* you don't measure it." Unless there is specific and detailed data of energy consumption at individual buildings or departmental levels, it becomes challenging to know how the energy is used or discover the efficacy of demand-side management programs.

To this extent, over the last five years, the management team at Agua Fria Union High School District made great strides in quantifying where every energy dollar is spent. Their ongoing efforts to bring to the surface a total energy picture and costs made many of the details of this report possible. Figure 4 is the current energy use by load. The district has quantified data for such areas as lighting, cooling, space heating, hot water, ventilation, plug power (computer loads), and miscellaneous loads representing every day items such as the ubiquitous coffee pot, microwave oven, or refrigerator.

The Department of Energy estimates that for every five computers, HVAC loads are increased by 25 percent. Furthermore, for every 20 computers HVAC loads are doubled. According to District officials, computers now number over 1,000 district-wide, adding to the connected electrical load. The percentages of these loads are illustrated in a pie chart

(Figure 4) as resistance load. Although the resistance load for the Agua Fria District is twenty-four percent, the heat generated by the computers also impacts the HVAC load.

Figure 5 is a chart developed in a detailed Energy Audit and Investment Analysis by The Energy Group in 1997. At the time, there was little empirical data of where their energy dollar was used. Although it has significantly improved since then, there are still many data points that need to be measured.

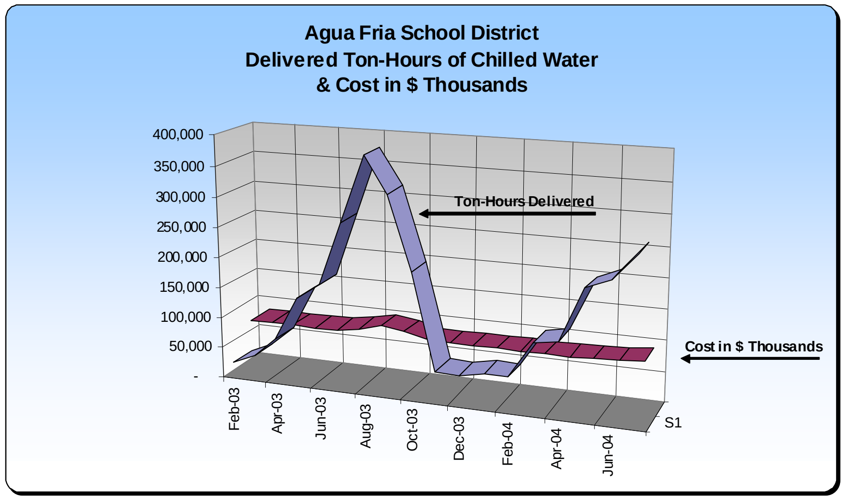


Figure 6

CHPS & LEED Who Are They?

The Collaborative for High Performance Schools (CHPS), a California-based non-profit organization focused on improving the overall performance of California schools, has developed a set of criteria that define a high performance school. The criteria are most useful as a goal setting and planning tool and are flexible enough to allow designers to deliver a CHPS school while managing the regional, district, and site-specific constraints of the school design.

The CHPS Criteria are similar to the U.S. Green Buildings Council's (USGBC) LEED™ 2.0 Rating System. The Leadership in Energy and Environmental Design (LEED) program was developed in the mid-1990s by members of the USGBC to recognize achievements and promote expertise in green building. The CHPS Criteria, developed a few years later, has the same goals. But unlike LEED, CHPS focuses only on school building design. A school qualifying for CHPS certification may contain many of the elements needed for LEED™ certification, but there is no interchangeability between the two systems.

Delivered Commodity

The delivered chilled water for each high school is illustrated in a graph in Appendix C-1.

The outsourced commodity delivered to the School District as an aggregate varies little in price even with the spike in use as found in Figure 6. Note the delivered chilled water spike has little incremental impact on the cost of the commodity. This chart is over a longer time line in order to get a perspective of use versus cost. Efficiency of all three school systems (Figure 7) shows a continuous trend of energy efficiency defined as a kilowatt per ton-hour. If this were a packaged system, this efficiency level could not be sustained, and in fact, degenerates as the equipment ages.

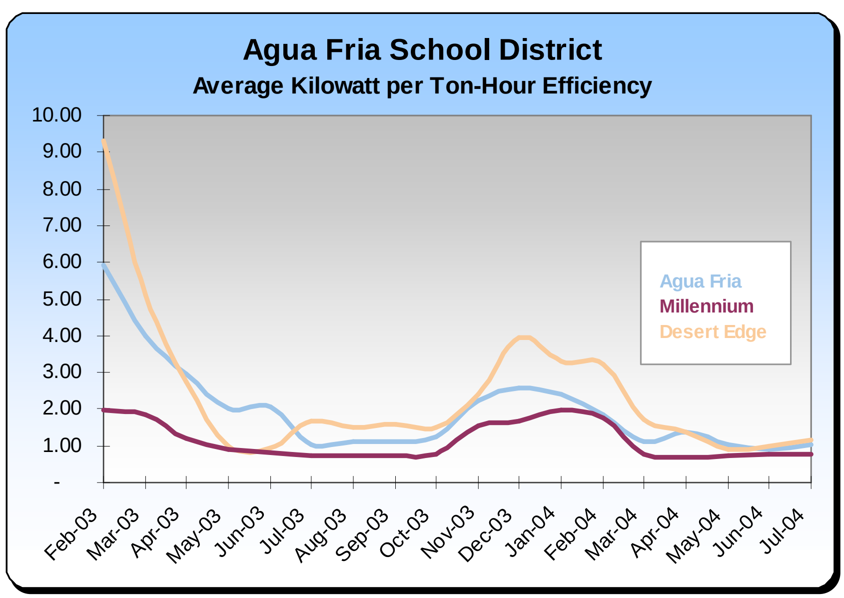


Figure 7

Education buildings account for 12 percent of all commercial energy consumption, using a total of 614 trillion Btu of combined site electricity, natural gas, fuel oil, and hot water.

Source: Department of Energy

Tolleson High School

Originally founded in 1912, the City of Tolleson, Arizona, is a community located 10 miles west of Phoenix. Incorporated in 1929, the City of Tolleson is about six square miles and has a population of over 5,000.

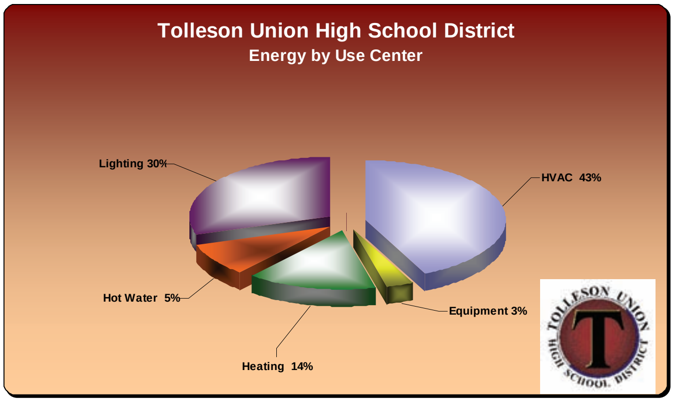


Figure 8

Tolleson High School District has a student population of over 5,119 and has grown to over 877,384 square feet. There are four high schools in the district including Tolleson which has a 292,496 square foot campus for 2,177 students, Westview which has a 360,466 square foot campus for 2,498 students, and finally, La Joya, a 224,422 square foot campus with 1,600 projected students. The newest high school added to the District is Copper Canyon which has a 250,000 square foot campus starting with 9th grade students.

Comparison of Energy Use

Figure 8 is an estimated use of energy in the different categories for the Tolleson District. Some of the Tolleson School District electricity bills used in this report are estimated from District trends. However, when comparing the Agua Fria District, Figure 9 clearly shows the efficacy of the demand side management efforts at Agua Fria. Although 33 percent of their energy uses are HVAC loads, they are well managed with the highest efficiency equipment available today; directly reflecting on the kilowatt hours per square foot use.

Obtaining current information about the energy use at the Tolleson School District was difficult, although what was received was used as a foundation for this report. A more accurate report would require a centralized data base consisting of current utility bills. The only energy use records available were from November 2001 through March 2003. There was no natural gas data available from the Tolleson district when requested. It must be said that a full set of utility bills were finally provided as this report goes to press.

The Tolleson District uses packaged HVAC systems exclusively in lieu of a central system. The penalty of running over 3,000 tons of packaged systems shows up in the utility bill, capital investment for replacement, excess utilities, and miscellaneous other places where various pieces of the M&O expenditures reside.

To compare and contrast the differences of a packaged system versus a district heating and cooling system, Figure 9 starts to uncloak the tip of the proverbial "iceberg." As can be seen, Agua Fria uses almost 5 kilowatt hours per square foot less energy each year. Although this equates only to about $50,000 a year at current electric rates, there are other considerations that tip the scales heavily in favor of a central HVAC system—at least for the Agua Fria District.

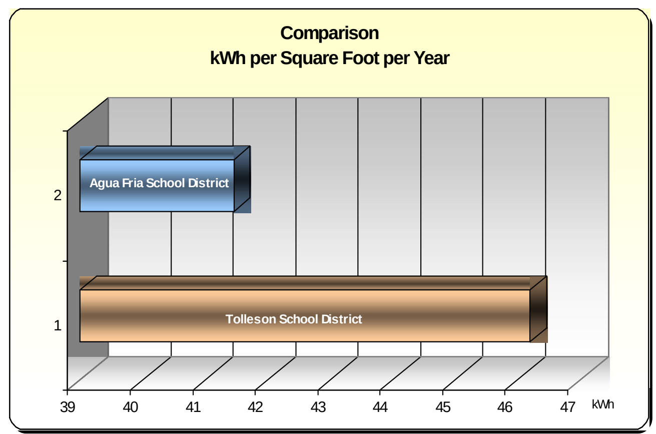


Figure 9

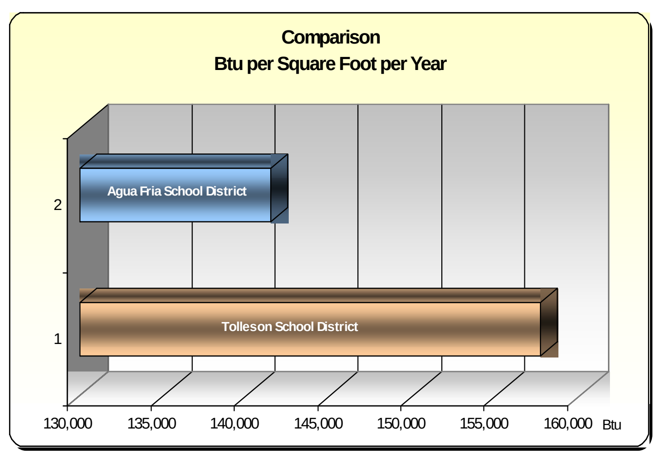


Figure 10

Water cooled systems provide the most energy efficient (HVAC) systems. . . . .

Source: Cooling Technology Institute

As part of the Agua Fria Districts drive to improve the performance of HVAC system, a central plant was installed at each of the three high schools. The cost of this effort would have required a major capital investment. However, under an outsourcing agreement they were able to have the system installed saving the district the need to issue more than $2.5 million in capital investment.

Under the agreement they were able to install two 1,000 ton systems and an 800 ton system including ancillary equipment with guaranteed performance by a Fortune 100 company. To add to the financial mix there was an additional $1.8 million for upgrades, replacement, and expansion made under the outsourcing agreement. Had the district used bond financing to pay for these systems, it would have incurred a debt service load of $300,000 per year. Other savings realized include the labor to operate and maintain such a system. When talking labor, one must include wages, benefits, and retirement. This transaction carries directly to the bottom line and frees up additional funds that can be utilized in the core business. This equipment has an economic life of over 15 years, and meets ASHRAE standards which helps mitigate potential litigation of IAQ claims.

Figure 10 further illustrates the savings, this in Btu's per square foot Agua Fria saved over the Tolleson District. No matter how one looks at energy, efficient use of energy resources goes directly to the bottom line for any business.

In contrast with the Agua Fria School District, the Tolleson District lacks necessary details to track energy dollars and does not have related metrics or cost controls needed to accurately compare the two entities. Data for these slides were taken from a blend of information from the public domain and detailed reports from the Agua Fria District.

The definition of a Btu, British thermal unit (One Btu is the amount of heat required to raise the temperature of one pound of water; one degree Fahrenheit.) The definition of a kilowatt-hour (kWh) is a unit of energy equivalent to one kilowatt (1 kW) of power expended for one hour. There are 3,412 Btu's in each kilowatt hour.

Eighty-three percent of school districts that had experienced an energy budget shortfall attributed the shortfall to increases in the cost per unit of energy.

Source: National Center for Education Statistics

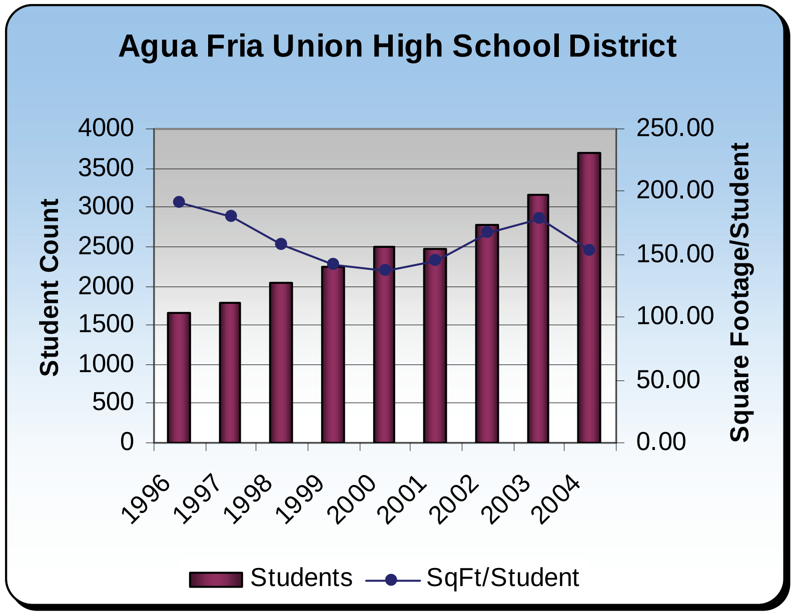


Figure 11

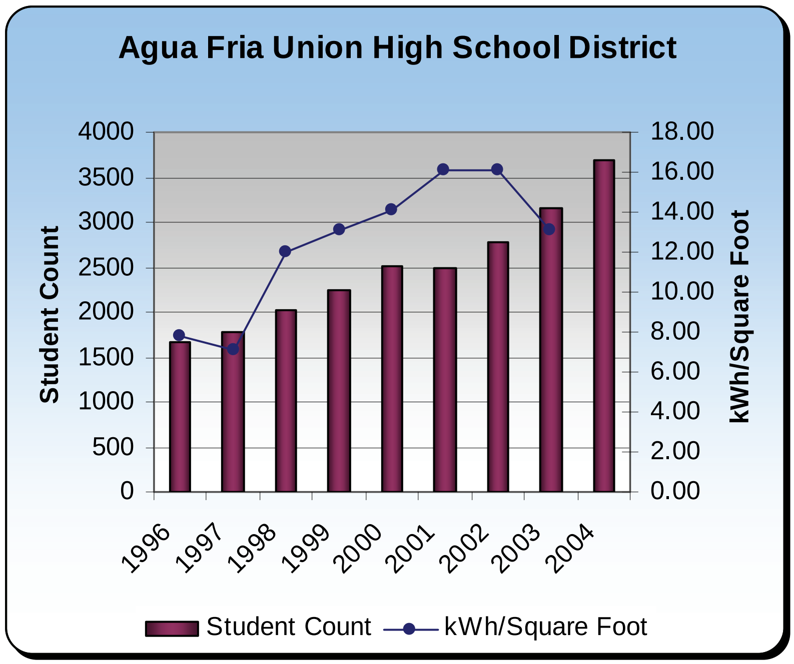


Figure 12

Energy Use Trends

Another way of contrasting the differences between the two districts is to compare the 1.) Square footage per student, and, 2.) Kilowatt hours per square foot. The data used for Figures 11 and 12 of these two charts were taken from the report cards issued for all school districts and from information supplied by the District.

While this set of graphs shows an ever increasing student population with a corresponding decrease of square foot per student. This shows a growing concentration of students per square foot. Figure 12 uses the same student count and compares the kilowatt hour consumption per student. A normal trend would scale in a linear fashion, whereas this trend is actually stabilized, and continuing a downward trend.

It becomes at once obvious that the Agua Fria District has focused their attention on reshaping the core focus back on the student.

Another troubling aspect of long-term bond obligations to fund short-lived equipment. As an example, Tolleson uses packaged units exclusively, many of which are over 20 years old. While their personnel may be able to work on these components and keep them running, the packaged units only work efficiently for less than 7 years in the Phoenix environment. They are subject to constant repair and replacement of internal components. Plant operations employees may debate this point, however, twenty year bonds paying for seven year equipment should be scrutinized when formulating a statewide policy.

While packaged units may appear functional and appropriate, they are actually consuming excessive energy and not furnishing the environmental conditions they were designed to deliver. To be certain, Tolleson has personnel that can replace compressors, motors, and other components. They have a full time employee going from one site to another performing maintenance on all of their systems. If a packaged system breaks down, they move the class to another room until that unit is fixed. To complicate the process, there is no list of equipment or the last time a component was replaced on any particular unit. Replacement parts and labor are charged to various budgets. Many of the cost of operations are hidden in many diverse cost centers and not exposed as part of the total operational costs. This compares unfavorably with preventive maintenance practices employed in other industrial settings.

By way of analogy, let us consider a parking lot lighting system that appears to be operational but fails to deliver the necessary foot-candles at ground level. This is called lamp depreciation. It is consuming electricity, looks like it is working but is in serious need of replacement. When it cycles off and on, in in-rush of current upon startup consumes more energy than a properly operating light fixture. The end-of-life lamp usually is not replaced until the area is dark creating a potential hazard.

The Outsourcing Solution

Outsourcing firms are seeing this as an opportunity to demonstrate that they can bring in an organized and managed company to do almost any part of the facilities work required. Some school districts are finding this to be an attractive option – especially when they're dealing with a staff resistant to change. For the most part, school districts have trouble attracting a qualified

People in Partnership
In the Application of Science & Technology

staff due to poor wage/hours conditions that exist in school districts.

School districts are re-examining their chartered mandates and are seeking to cut out their non-core immoderations in order to refocus on their core competencies. Outsourcing, particularly M&O, tree trimming, and IT responds to several needs of school districts including:

- The need to focus management's attention on core aspects of the academic process which produces competitive differentiation
- The desire to reduce operating costs
- The business imperative to access skills and capabilities not available internally
- The inability to adequately invest in new technology for non-core operations
- The inability to adequately address non-core personnel training for optimum building performance
- Avoiding the cumbersome planning process for maintenance (both scheduled & unscheduled) and replacement of equipment

School districts typically do not invest in proper plant management talent, capital, and put adequate resources into non-core business processes (nor should they). Often, third parties can offer the same or better service at a lower cost while reducing capital requirements and operational costs. It can also render a very predictable, line-item budget cost center. Hence, if a process can be done better and/or cheaper by others without sacrificing customer service, then it is a candidate for outsourcing.

In 2001 early adopters of the concept of outsourcing started to have an impact on utility management planning and decision making.

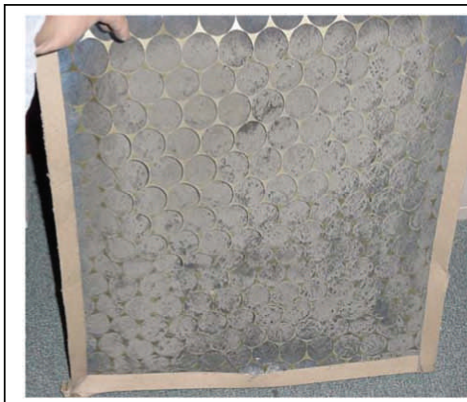
Although school districts noticed this outsourcing concept, there was no one creative enough to make it work, nor was there a strong corporate partner. In Arizona, there is little incentive to do anything outside the norm due to the risk adverse culture of school districts. And why should there be; their focus is on education, and not operating buildings.

There are many geopolitical forces and special interests are at work. Sometimes they collide. The forward thinking school administrators realize something must be done quickly. This was largely due to the fact that many school districts were becoming financially strained due to budget cutting legislation, reduced tax revenues, and public mandated change. Outsourcing, especially technologies and M&O were seen as a way to improve the school districts financial profile.

Caveat-Emptor

As with any transaction, outsourcing can have potential risks. School districts must institute a collaborative process under any circumstance so contractors fully understand what resources will be needed. Poor working relationships could impair communications and may jeopardize projects. If the entities have to integrate their operations, the management styles may differ. And, finally, they may have differing opinions on technologies, manufacturers, or even design which will take a toll on partnerships ability to properly function. However those potential obstacles can be overcome, by identifying a trusted outsourcer who understands the bottom line is that this is a long-term partnership requiring a long-term collaborative relationship which will have to be closely managed.

The Agua Fria School District comes to mind when looking for a case study of the success of collaboration. The outsourcing companies should understand all upfront costs and keep working together for a successful transaction. Lastly, school districts should engage all stakeholders in a collaborative process and obtain a thorough legal review prior to entering the contractual phase. Simply stated, this is good risk management.



Dirty air filters reduce airflow.
This filter removed from a classroom.

With financial pressures mounting, school districts must focus the bulk of their resources on mission-critical functions and outsource certain non-educational operations, as did the Agua Fria Union High School District.

Although the contractor is being paid for services, aside from the savings by the school district, there can be great benefit not by managing, but partnering with the vendor. Partnering in this sense is not a legal partnership, rather a long-term commitment to achieve certain objectives as a team. This should be a relationship based on trust, shared goals, and understanding that can be significantly beneficial to both parties. Ultimately the district, and moreover, the student wins in this relationship.

Regulating Energy Design

California developed Energy Efficiency Standards as mandated in Assembly Bill 970. California Title 24 Building Energy Standards were developed in 1978 as a result of this mandate. Title 24 has been very effective in reducing energy use throughout the state which also applies to all K-12 school buildings. Title 24 Nonresidential Standards were made more stringent in 2001 however there are still numerous cost-effective options that are practical. It is a straightforward regulation with a cornucopia of efficiency measures to choose from that can reduce a school's energy use beyond the current building standards. This is important when considering the long-term cost of operation. The Nonresidential Manual is a supplement to the Title 24 standards.

The latest draft of the 2005 Building Energy Efficiency Standards tightens the standards for chilled water plants with more than 300 tons total capacity "shall not have more than 100 tons provided by air-cooled chillers" (Section 144 (i) 1). Generally speaking, when an aggregate load of over 150 tons of packaged load exists on a contiguous property, consideration of a central chiller plant *should be evaluated*. This becomes law October 2005.

Energy Definitions

1 kilowatt-hour = 3412 Btu

1 Ton cooling capacity = 12,000 Btu/hr = 3.517kW

Btu = British thermal unit—amount of heat needed to raise one pound of water one degree Fahrenheit

In response to a shortfall in the energy budget, 8 percent of districts raised school taxes and 8 percent rolled over the under-budgeted amount to the next fiscal year.

Source: National Center for Education Statistics

Another important element for classrooms is lighting which can be an expensive proposition without consideration of proper design. Lighting for classrooms under the current code allows for up to 1.4 watts per square foot of lighting. Schools can easily attain 1.2 watts or less with good design and the latest in lighting technologies. There are other options such as using daylighting to further reduce energy use.

Daylighting is especially effective when considered in the design phase of new construction. A study conducted by the Heschong Mahone Group for Pacific Gas & Electric found a compelling connection between student performance and daylighting. Daylighting in Schools An investigation into the Relationship Between Daylighting and Human Performance.

Research shows that new commercial construction can achieve 50-percent energy savings using an integrated design approach and carefully implemented energy performance strategies.[5] In recent years, several initiatives targeting energy use and promoting energy efficiency have emerged. The two most prominent are Energy Star www.energystar.gov and Leadership in Energy and Environmental Design (LEED) www.usgbc.org/LEED , which are helping set in motion a shift in thinking about energy and resource consumption and indoor environmental quality.

LEED is a voluntary, points-based, national standard for developing high-performance buildings; that is, buildings that benefit from a more-integrated, better-planned design process. Think of LEED as a framework for informed, educated design, as well as a quality control mechanism. LEED evaluates "greenness" in five categories: Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, and Indoor Environmental Quality.[6]

LEED-NC is the rating system for new construction and major renovation projects. LEED-EB, the rating system for existing buildings and system improvements, is in the pilot phase and expected to be available this year. The goal of LEED-EB is to help building owners operate their buildings in a sustainable way year after year.

In the Energy & Atmosphere category, prerequisites include fundamental building-systems commissioning and minimum energy performance. The latter is defined as meeting ASHRAE/IESNA Standard 90.1-1999, Energy Standard for Buildings Except Low-Rise Residential Buildings, or the local energy code, Whichever is more stringent. Whether owners decide to go beyond the LEED prerequisite is up to them. The first 53 LEED-certified buildings were an average 30 percent above code in terms of energy efficiency. Designers of some of the buildings opted not to pursue energy efficiency and instead focused on other LEED categories.

It should be noted that the Agua Fria School District is the *only District in Arizona with a registered LEED high school project*.

Designs for high-performance schools generally emphasize "daylighting," the use of natural light. Combined with healthy indoor air quality, this not only improves students' health but also enhances their performance. This study analyzed test scores for more than 21,000 students from three major school districts and found that those students with the most daylighting progressed up to twenty percent (20%) faster on math tests and twenty-six percent (26%) on reading tests than those with the least. Several other studies have reached similar conclusions.

California Occupational Safety and Health and Standards Board promulgated by the Department of Industrial Relations has established regulations for classroom HVAC systems. The regulations require employers to provide continuous outdoor air ventilation to rooms during all working hours in accordance to the building permit ventilation design.

High CO_2 Levels in a Classroom

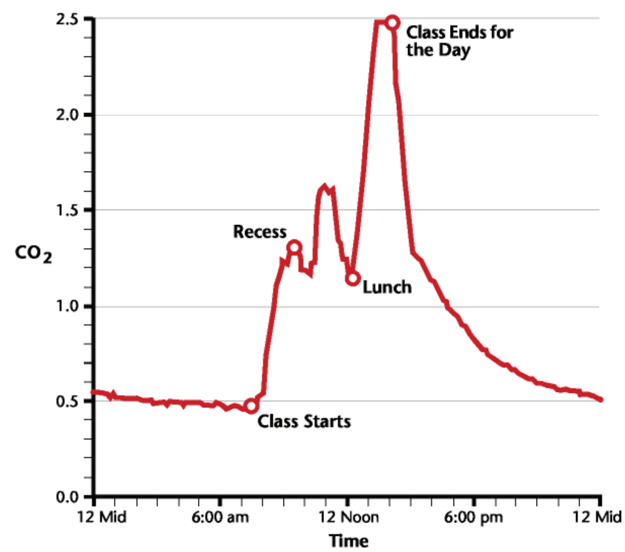


Figure 13

The mission of a school's HVAC system is to provide comfort and good indoor air quality. The goal of an HVAC maintenance program is to meet those needs while also ensuring reliability, energy efficiency, and minimum system life cycle cost. The benefits of careful maintenance of HVAC systems include lower energy costs, lower overall maintenance cost, better indoor air quality, longer equipment life, potentially better occupant comfort, and better information for facilities planning.

Source: New York State Energy Research & Development Authority

5) From the U.S. EPA's "New Building Design Guidance and Target Finder," available at www.energystar.gov/ia/business/building_design/NBD&TFJnal.pdf

Employers are required to operate and maintain the HVAC system as designed. The regulations also require annual inspections, and provide copies of inspection and maintenance records to employees upon request. Refer to Safety Orders on the Control of Hazardous Substances. Figure 12 is an actual classroom with poor indoor air quality. CO_2 sensors, controls, and a good air exchange would solve this potentially hazardous situation. Maximum levels of carbon dioxide for classrooms are recommended by ASHRAE (American Society of heating, Refrigerating and Air-Conditioning Engineers) not to exceed 1,000 ppm. Outdoor levels are typically 350 ppm. (Weiss, 1994) School officials and their legal staff should be cognizant of the implications of high CO_2 levels in classrooms.

It must be noted that Agua Fria School District has made extensive inroads to this problem through their risk management practices. They installed CO_2 sensors to control any buildup of CO_2 levels to predetermined setpoints.

School districts that lease portable classrooms from the State of California must ensure that the classrooms are maintained in good repair and working order at all times. Refer to the State Relocatable Classroom Program Handbook.

Energy Cost Per Student

It is an undisputed fact that high performance schools cost less to operate. First cost is not an option for long term system efficacy. With that said, school districts that strive for high performance predictably spend less for electricity, gas, water, maintenance and operating costs. Those monies are better spent for salaries, books, teaching supplies and other items with a more direct link to their core competencies and true mission of schools, that of educating students.

The US Department of Energy (DOE) estimates that the nation's average school utility costs are approximately $125 per student per year, when one takes into account water, wastewater processing, and trash. A high-performance school can yield savings of up to $50 per student per year.

How much savings can be expected? According to the USEPA, school districts can save thirty to forty percent (30–40%) on annual utility costs for new schools, and twenty to thirty percent (20–30%) for renovated schools by applying high performance design and sustainability concepts. The potential for savings is greater in new schools because all inefficiencies can be "designed out" from the onset, thereby accumulating savings year after year for the life of the structure.

LEED®, the "Leadership in Energy & Environmental Design" Green Building Rating System, is the nationally accepted standard for green buildings developed by the USGBC membership.

As with the DOE, the California Energy Commission (CEC) estimates the average cost of energy is $126 per student. Expenditures for electricity and natural gas typically run 2.2% to 2.7% of the total schools budget. High performance design could yield savings of up to $50 per year per student with aggressive designs which corroborates the DOE estimates. Furthermore, these savings continue to reap benefits as long as they are used as designed, and properly maintained. Integrated design is the key to savings of this magnitude. From the very beginning of the design process, each of the building element (windows, walls, building materials, air-conditioning, landscaping, etc) is considered part of an integrated system of interacting components. Choices in one area often affect other building systems; integrated design leverages these interactions to maximize the overall building performance.

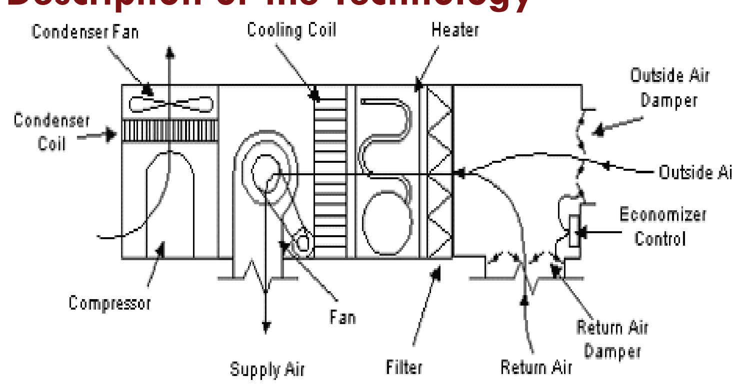
On a national level in a fiscal year 2000 survey conducted by the National Center for Education Statistics found that, on average, school districts spent $137 per pupil on energy. For some reason these suggest a higher cost than the DOE and CEC numbers. Spending increased per student in FY 01 to a whopping $166 per pupil, 22 percent higher than in FY 00. School districts budgeted $176 per pupil for FY 02 energy needs, or a 6 percent increase over what it actually spent in FY 01. This $24 per pupil increase over FY 01 translates into an increase of about $1 billion.

Packaged Cooling Systems

The packaged HVAC system has been around since mechanical engineers started offering forced air heating and cooling to offices, merchants, industries and residences.

In many design situations, engineers have become very dependent upon HVAC manufacturers to provide them with a range of complete packaged HVAC systems to fit various applications. There are numerous

Description of the Technology



HVAC manufacturers who offer specific packaged systems that will fit many specific client needs. There are also many manufacturers who cover a wide range of sizes, quality levels and types of systems.

The definition of a packaged system may vary slightly by manufacturer and engineer. In general, a packaged system is a pre-assembled piece of HVAC equipment that is constructed using two or more individual components to operate as one complete system. This definition covers a broad spectrum of equipment. Packaged units include, but are not limited to, chillers, unit heaters, rooftop units, custom air handlers, and many VAV applications.

The benefits of a packaged HVAC system are normally first cost of equipment and installation.

- Packaged cooling systems are factory-made assemblies in various configurations that provide space heating, cooling, and ventilation. Do not confuse packaged AC with Central AC, or chillers, typically used in larger buildings. The most common is the single-package rooftop system.

- Single-Packaged Units: All components are in one factory-made assembly. These units provide conditioned air through ductwork. Roof-mounted units are more popular than units on ground-level concrete pads. Units including gas heaters are sometimes called "gas-packs." Units mounted on an exterior wall are commonly called "wall-packs."

- Split-Systems: Split-systems are popular in small, single-story buildings. An indoor section and a matching outdoor section are connected by refrigerant tubing (hence the name "split"). The indoor section usually consists of a fan, indoor cooling coil, heating section, and filter. The outdoor section houses the compressor and condenser. Energy performance is similar to single-packaged units.

- Packaged Terminal Air Conditioners (PTAC): These are packaged units (i.e., they contain all the heating and cooling components in one unit), but are intended for through-the-wall installation. They are much smaller than rooftop units because they are designed to serve a single room. Simple controls are located on the unit.

Air cooled (Packaged) systems may offer first cost incentive to sacrifice energy efficiencies of water cooled systems.

Source: Cooling Technology Institute

District Heating & Cooling

What is district energy? District energy systems are a nearly-invisible infrastructure which provides heating and cooling to a building or series of buildings. It is usually a centrally located mechanical equipment room or building where boilers, furnaces, chillers, and compressors are housed. For schools, thermal energy is carried to each classroom through an underground network of insulated hot water, chilled water, or steam pipes.

District heating dates back to Roman times when warm water was circulated in open trenches to heat buildings and communal baths. The first modern district heating system was introduced in Lockport, New York in 1877. District cooling did not begin until the Colorado Automatic Refrigerator Company began operating in Denver in late 1889. Many early systems supplied ammonia and brine for refrigeration of meat, as well as cooling restaurants, theatres and other public buildings. Large district cooling systems were built in the 1930s in Rockefeller Center and the United States Capitol complex.

The oldest district heating system still operating warms a French village from geothermal hot springs in the early fourteenth century. A steam district heating system has been in use at the U.S. Naval Academy since 1853, and the oldest commercial district heating system still operating began service in Denver on November 1880.

Since 1990, on a nationwide basis, district energy systems have increased over 242,370,623 square feet of buildings installing and using district energy systems. District energy has a worldwide proven track record of saving energy, money, and reducing source pollution.

District Heating & Cooling System

Figure 14 Desert Edge High School

Advantage of a District Heating & Cooling System

1. Lower Capital Costs
Principal and interest payments, property taxes, and insurance costs associated with new boiler and chiller installations are all eliminated with district heating and cooling. The only initial costs for district energy are for a heat exchanger and related piping and valves.

2. Lower Energy Costs
District energy can optimize purchasing only the energy needed to meet student comfort. There is no ongoing capital expense related to upgrades, remodels, or maintaining excess capacity. A drawback for a packaged system (i.e., hot water heaters and air conditioners in each building) are normally designed to carry excess capacity to meet occasional peak demand, which leads to inefficient partial boiler and chiller loading during most of the year. Operational costs escalate directly due to poor seasonal efficiency. In glaring contrast, central boilers and chillers nominally operate and achieve the highest seasonal efficiency possible.

3. Lower Operations & Maintenance Costs
With district energy a school district has less need for highly trained on-site maintenance and operating personnel, and costly annual maintenance contracts. Boiler and chiller operating expenses (i.e. electricity, water treatment chemicals, insurance, refrigerant, and make-up water) are all eliminated.

4. Predictable & Stable Costs
District energy systems can convert to the least costly and most available fuel, and thus achieve economies of scale with volume purchasing. Systems are able to take advantage of municipal solid waste systems where they are available. They can also utilize waste heat from electrical generation plants, which is not practical with in-building systems due to an imbalance of electric and thermal loads.

5. More Educational Space
Centralizing an energy system for a campus creates more useable space because it frees up valuable floor space for additional educational purposes, and increase architectural flexibility. Implementation of district energy for a school campus reduces vibration and noise problems. Additionally, if water heaters are used for each building, district energy eliminates the need for multiple roof penetrations.

6. Reliable Heating & Cooling
A district energy system typically is easier to maintain than a distributed system. Centrally located systems are on strict maintenance schedules, and can be switched to a reserve fuel source as needed. As with hospitals, a backup capacity and redundancy is always ready and available, without the need for additional reserve boilers.

7. Lower Costs of System Expansion
A district energy system is flexible enough to expand due to fixed capital and operating costs which are spread over a large base. This creates a stable and predictable cost.

8. Reduced Source Pollutants
District energy reduces the number of source emissions throughout the school campus. It reduces emissions since a larger system are easier to control. Reactive organic gases, sulfur oxides, carbon monoxide, oxides of nitrogen, carbon dioxide, and particulate matter are easily controlled on larger boilers through several inexpensive technologies.

400 Ton System Comparison
System Energy Requirements

400 Ton Air-Cooled Chiller System

	KW/Unit	Total KW
Compressor	406.00	406.00
Condenser fans	62.50	62.50
Air handling units	22.37	111.85
Chilled H_2O pump	14.92	14.92
Total KW		**595.27**

KW/ton = 595.27/400 = **1.49KW/ton**

400 Ton Centrifugal Chiller System

	KW/Unit	Total KW
Compressor	220.0	220.00
Air handling units	22.37	111.85
Chilled H_2O pump	14.92	14.92
Condenser H_2O pump	11.19	11.19
Cooling tower fan	18.65	18.65
Total KW		**376.61**

KW/ton = 376.61/400 = **0.94KW/ton**

For the prospective school district, a district energy system has a number of short and long term technological and economic recompense. Economy of scale plays a major role by eliminating, or greatly reducing many of the associated activities as operation and maintenance (scheduled & unscheduled), replacement cycle of boilers and chillers as opposed to a distributed system throughout the campus.

If a chiller is 10 years old, or older, a significant savings can be garnered by merely replacing it with an energy-efficient machine. For example, a 500-ton chiller with an efficiency of 0.75 kW/ton operated at full load for a full year will consume 3,285,000 kWh. A new machine operating at 0.5 kW/ton, or less, would provide an annual energy use savings of 1,095,000 kWh. Assuming an average electrical cost of $0.05 per kWh, there would be a savings of $54,750 per year. An electric centrifugal chiller costs about $250 to $300 per ton of capacity. Depending on the cost for a new chiller, replacement would provide about a two-year payback. Whenever chillers or compressors are due for an overhaul or repaired, one should consider replacement of outdated equipment with a high efficiency machine as a cost-effective measure.

Advantages of Central Energy Systems for School Districts and Society

Benefits to school districts

- Use of available energy sources within the community, thus retaining energy dollars
- Employment during construction
- Increased effective use of local energy sources—decreases the amount of imported fuel
- Access to low cost energy sources
- Elimination of multiple boilers, furnaces, and chillers
- Reduced labor and maintenance cost
- Reallocation of space for other purposes
- Increased reliability of supply of thermal energy
- Improved indoor air quality

Benefits to society

- Improved use of energy
- Increased effective use of local energy sources
- Reduced source emissions
- Improved air quality
- Better allocation of tax dollars

Summary

This report was commissioned to examine several energy related issues including an analysis of the Agua Fria Districts use of a central approach of district heating and cooling. Included in this study is the comparison of the Tolleson Union High School District campus which uses a packaged HVAC system exclusively. And finally, this study analyzes Outsourced Commodity as an alternative to owning, operating, and maintaining the districts boilers and HVAC equipment.

A site survey of both school districts revealed many differences. The first was in regard to the exceptional cleanliness of Aqua Fria's central plant operations. Second, quality or workmanship was superior as evidenced by Figure 14 – the plant installation at Desert Edge High School.

A third difference is the minimal use of packaged units at Aqua Fria. In contrast, Tolleson School District uses packaged units throughout, many of which are over 20 years old. One can only imagine what the classroom air quality is at the end of the day.

Fourth is the ability to provide vital energy data in a short period of time. Agua Fria has an abundance of useful energy information that is accessible in moments. The age-old maxim that says "You can't manage what you can't measure" has no greater meaning than in energy and air quality management. It should be mentioned that carbon dioxide levels are inversely related to air quality; and at Aqua Fria, CO_2 is constantly measured and automatically controlled at the classroom level.

Another need is to have current data available. At this writing, the Tolleson School District's most recent utility data was as of March 2003, and there was no natural gas information available at all. Data must also be reviewed and acted upon by management. At Tolleson, there was no evidence of a meaningful review by someone having the expertise and authority to effect changes or improvements.

A fifth difference is the availability of an inventory of site mechanical equipment and historical maintenance data. At the Tolleson School District, no such information was available.

Outsourced commodities are not new for universities, colleges, and school districts. There are many examples of central heating and cooling systems in the educational realm. Highlighted in Appendix F-1 are just a few examples of centralized systems, some of which are owned by the institution, while others are owned and operated through an outsourcing agreement.

Energy outsourcing emerged as a logical solution to a difficult challenge; specifically, to cut operational costs in order to preserve and improve the core educational programs. An impressive benefit of outsourcing is the transfer of costs and administrative burdens of plant engineering and related maintenance functions to outside experts.

This concept of purchasing needed services rather than *providing* them is exemplified in other ways that we all take for granted – buying textbooks as opposed to publishing them; buying gas and electricity rather than generating these commodities internally; laundry and linen, postal and parcel services; insurance protection, air travel, equipment purchasing, and so forth.

> The greatest benefit of outsourcing is the efficiency and quality that result from expert management.
>
> Source: *Outsourcing Support Services*, American Association of School Administrators

Three chillers at the City Centre Chiller Plant.

Courtesy of Ameresco

Figure 15

The need to increase productivity and decrease expenses is pressing. Academic institutions are scrambling to get their financial houses in order to meet the current and future budget constraints. They have to bolster operational efficiencies, but have been hamstrung by deferred maintenance. By focusing on delivering quality education to the student body, school administrators can again be proud of being a cornerstone of society giving students full attention to the learning process.

The following summarizes the benefits of an *Outsourced Commodity Program:*

Full Focused Analysis of Needs: Through the preliminary engineering review, all current equipment is cataloged and measured. Needs both now and over the contract term are examined and a plan for upgrades, replacement, or modification of equipment is developed. Ancillary equipment/services that are necessary for optimum performance such as water treatment systems, and cooling towers are examined. On-site generation can also be included in this program.

Avoidance of Capital Expenditures: Through the use of an Outsourced Commodity Program, the customer may wish to recover immediately their invested capital for equipment installed, and avoid any additional capital expenditures for replacement of exiting equipment and expanded needs on each location. The existing central plant facilities will be upgraded for extra capacity, as the needs demand it.

Future capital will be needed to replace existing package units due to failure of compressors. Package unit compressors usually have a service life of 10 to 15 years, at which time a major capital expense and possible service interruption is incurred.

> “the district has saved $20 million over the past three years by outsourcing building maintenance management.”
>
> Source: William Coleman, COO Detroit Public Schools

400 Ton System Comparison
System Energy Requirements

400 Ton Roof-Top System: (5) 80 Ton Units

	KW/Unit	Total KW
Compressor	74.65	373.25
Air handling fan	29.84	149.20
Condenser fan	8.60	43.00
Total KW		565.45

KW/ton = 565.45/400 = **1.42KW/ton**

400 Ton Self-Contained System: (5) 80 Ton Units

	KW/Unit	Total KW
Compressor	63.12	315.60
Air handling fan	22.37	111.85
Condenser H_2O pump	11.19	11.19
Cooling tower fan	18.75	18.75
Total KW		457.39

KW/ton = 457.39/400 = **1.14KW/ton**

Predictability of Capital Costs: Equipment costs associated with increases in building loads caused by changes occupancy, usage patterns, or expansion will be the responsibility of the service provider, not the school district. Because of this, customers will enjoy a high level of certainty concerning future budget needs.

Dependability and Reliability: Outsourced central plants provide the ultimate in reliability and redundancy. Dependable service is enhanced by the availability of replacement components onsite. Plants are also designed to meet peak system cooling load requirements.

Expandability: Over time, the customer will require modifications, upgrades, and added equipment to meet the needs of growth and technological change. In outsourcing, the cost for this is borne by the service provider.

Relief from the Maintenance Burden: The service provider assumes all operational costs including supervisory and maintenance personnel, and supplies. This includes major overhauls, upgrades, and replacement when needed.

Provides Market Rate Economics: The preliminary analysis is developed with the full participation of the customer's site. This ensures that the customer is in full agreement with their current ongoing total cost of self-generation of the central plant output.

Environmental Concerns: *A centralized plant provides a non-CFC option that has minimal an ozone depletion factor versus package units that typically use CFC.*

Conclusion

School districts in Arizona need to find alternatives to their funding shortfalls for M&O and new construction. One of the few options is to operate more efficiently starting with the basics of energy efficiency. This can be done through Demand Side Management where most of the "low hanging fruit" has already been picked, or it can be done by looking at the paradigm through a different prism; one of outsourcing.

The goal of management at Agua Fria Union High School District's was to develop a program that delivers accountability, a high quality learning environment, substantially measure ongoing cost reductions, and avoid impacting the district's credit and bond capacity. Their goals and objectives were met with stunning results.

The downward trend in energy use is a testimony to the efficacy of their continuous energy efficiency improvements. Not only were those goals achieved, but they were able to assure the guaranteed delivery of an environment conducive of learning. They established professional management of this program ensuring direct accountability for which they should be acknowledged.

It must be remembered that this effort is a work in progress. There are many other parallel activities that need to continue, such as expansion of this concept into other energy related areas within the district. Although the learning curve of this effort was quite steep, the teams forming the nucleus worked in collaboration throughout the process. It was especially interesting to see the interaction between the team members. There is a close collaborative process clearly driving this goal oriented partnership through teamwork.

Outsourcing is a tool that has helped schools improve their educational focus, has freed administration from day-to-day plant services operations oversight, and has implemented significant improvements in the level of professional service.

The day of the well-meaning novice serving as the primary service technician for a multi-million dollar central plant is over. We do not allow well meaning novices to substitute for competent architects and engineers when we construct the brick and mortar of a school and we should not allow it when we design and build the environmental delivery system infrastructure of the school.

The Agua Fria School District structured the outsourcing transaction to carry all the risk of ownership, performance, and operation. They shifted all liabilities to the third party, which includes, but is not limited to, casualty insurance, annual accounting and legal fees, continuous monitoring, water treatment, equipment replacement and breakdown, federal and state taxes. They only pay for the delivered commodity and demand charge. This is a major shift in removing many non-core liabilities from the academic process. This whole process revealed actual cost of operation in real costs; manpower, service, repair, supplies, utilities and actual consumption of energy just to name a few. This school administration knows what the cost is to purchase a ton-hour, they also know into the future what the cost will be. The only variable is the consumer price index and actual usage. No other school district can claim this kind of predictability.

These early pioneers of the outsourcing approach in public schools are well qualified to serve as a shining model for other school districts in Arizona wanting to minimize energy-related expenses and focus on their core competency – education.

System Energy Comparison

Chiller Systems

Air-Cooled Chiller System	1.49KW/ton
Centrifugal Chiller System	0.94KW/ton

Packaged Systems

Roof-Top Units	1.42KW/ton
Self-Contained Units	1.14KW/ton

System Cost Summary

	Installed Cost	Energy Cost
Chiller System		
Air-Cooled Chiller	$455,600	$107,149
Centrifugal Chiller	$498,400	$ 67,790
Packaged Systems		
Roof-Top	$275,000	$101,781
Self-Contained	$324,800	$ 82,330

HVAC System Installed Cost Estimates by Source

Air Cooled Chiller	$350/Tr X 1.50
Centrifugal Chiller	$250/Tr X 1.50
Roof Top Units	$550/Tr X 1.125
Self Contained Units	$400/Tr X 1.50
Air Handling Units	$1.00/CFM X 1.25
Cooling Towers	$45/Tr X 1.50
Pump/Piping	Means Mech. Estimate
400 Ton Air Cooled Chiller	$210,000
(5) 28,000 CFM Air Handlers	$175,000
1,000 LF Chilled Water Piping	$ 67,000
Chilled Water Pump	$ 3,600
Total installed cost	**$455,600**

Installed Cost Estimate Roof-Top System

(5) 80 Ton Roof Top Units Installed Cost $275,000

Source: Cooling Technology Institute

400 ton Centrifugal Chiller	$150,000
400 ton Cooling Tower	$ 27,000
(5)28,000 CFM Air Handlers	$175,000
1,000 LF Chilled Water Piping	$ 67,000
400 LF Condenser Water Piping	$ 26,800
Chilled Water Pump	$ 3,600
Condenser Water Pump	$ 4,000
Mechanical Equipment Room	$ 45,000
Total Installed Cost	**$498,400**

Installed Cost Summary

Chiller Systems	
Air Cooled Chiller	$455,600
Centrifugal Chiller	$498,400
Packaged Systems	
Roof Top	$275,000
Self-Contained	$324,800

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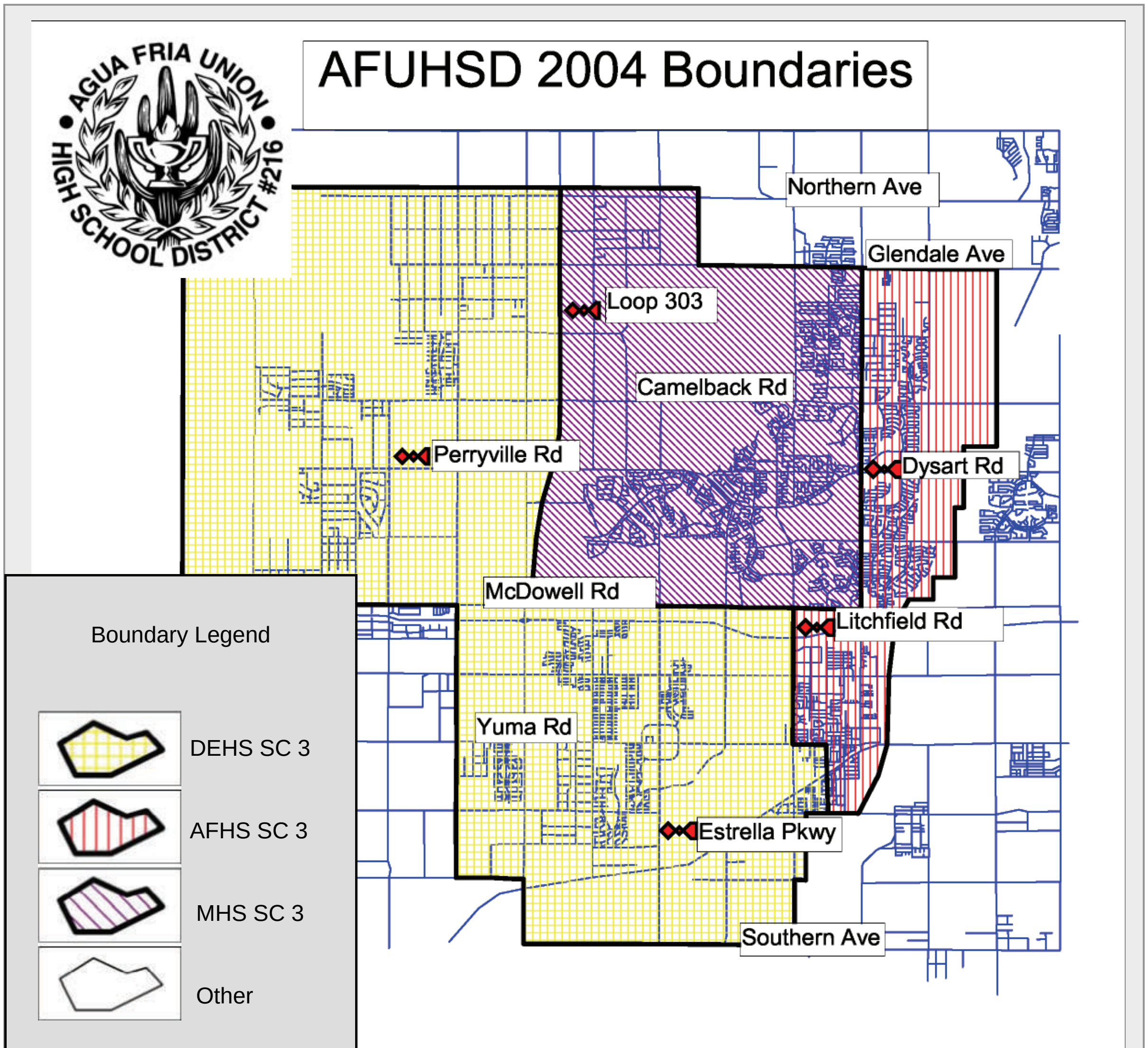
Biographical

As a Certified Energy Manager and president of Golden State Energy in Carson City, Nevada, Thomas Damberger has over 23 years in the energy industry. He holds a Ph.D. is in Applied Management and Decision Sciences from Walden University—Minneapolis, and a Master of Public Administration from California State University—Long Beach.

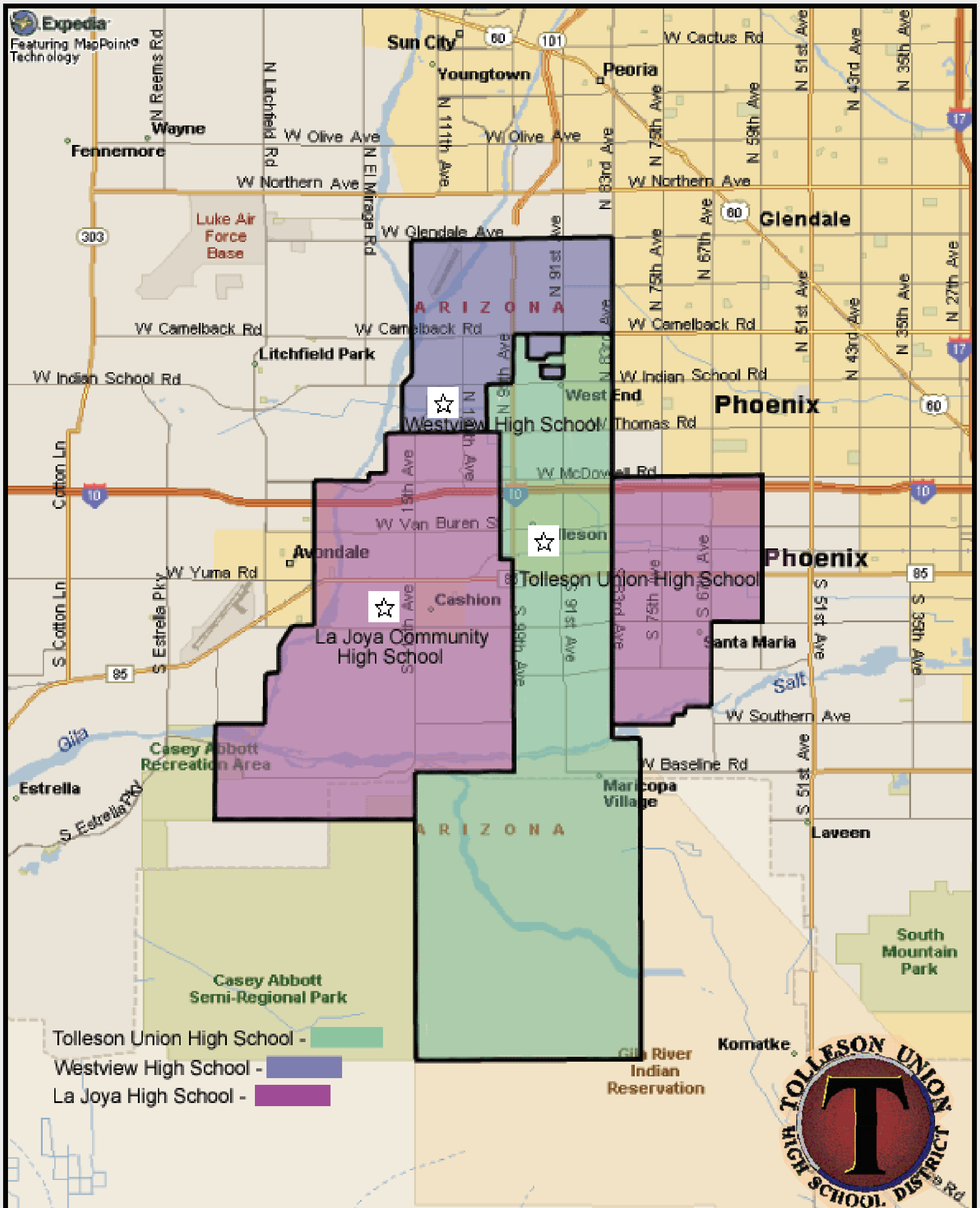
Dr. Damberger has received the prestigious Clean Air Award from the South Coast Air Quality Management District, and Special Recognition for Outstanding Contribution in Promoting an Environmentally Sustainable Energy Future from the Secretary of Energy at the United States Department of Energy. More recently, after completing several CHP systems, he is now working at improving the environmental conditions and performance of school district assets in California.

APPENDIX A-1 Map of Agua Fria Union High School District



Agua Fria Union High School District Boundaries

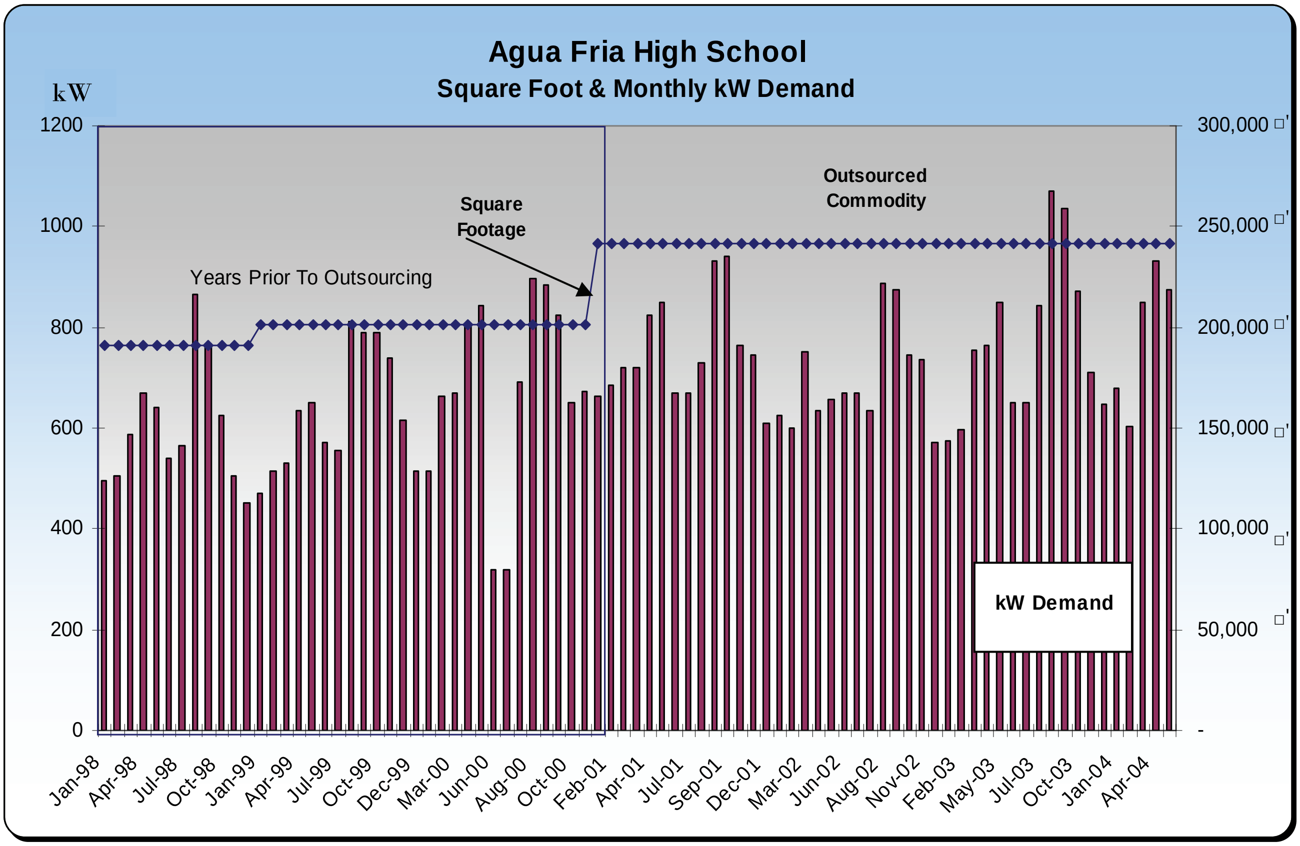
APPENDIX A-2 Map of Tolleson Union High School District

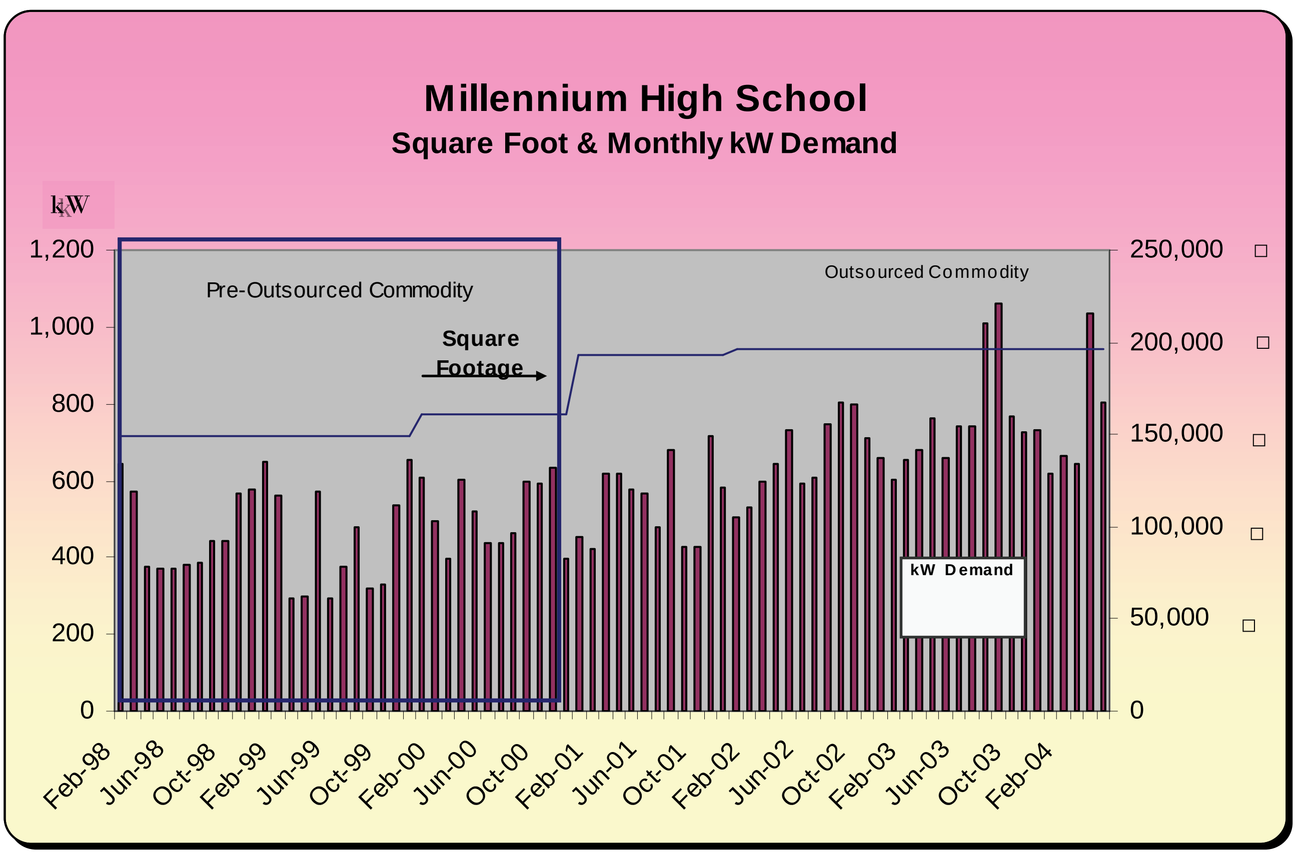


Tolleson Union High School District Boundaries

APPENDIX B

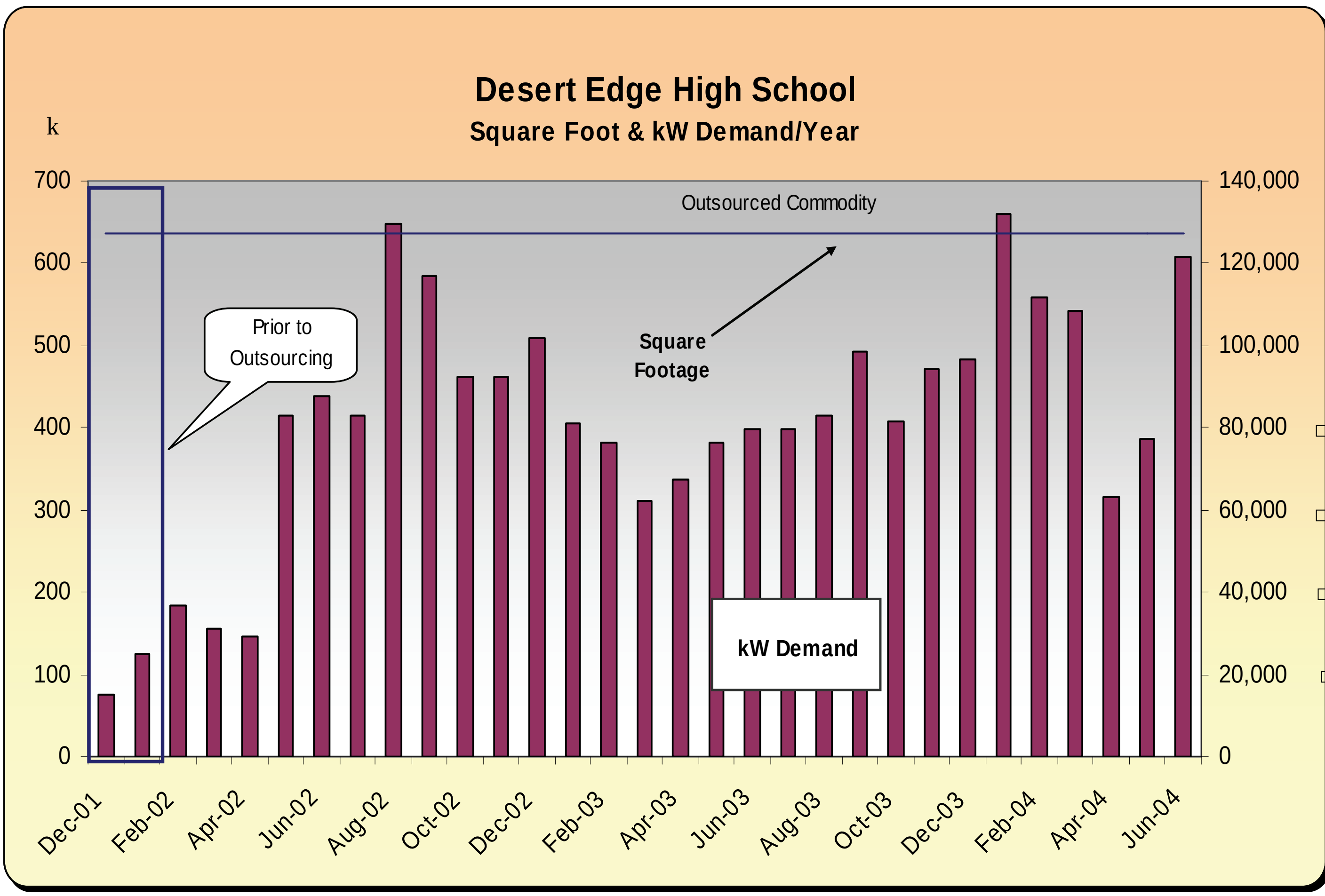
Agua Fria School District Square Footage & kW Demand by High School





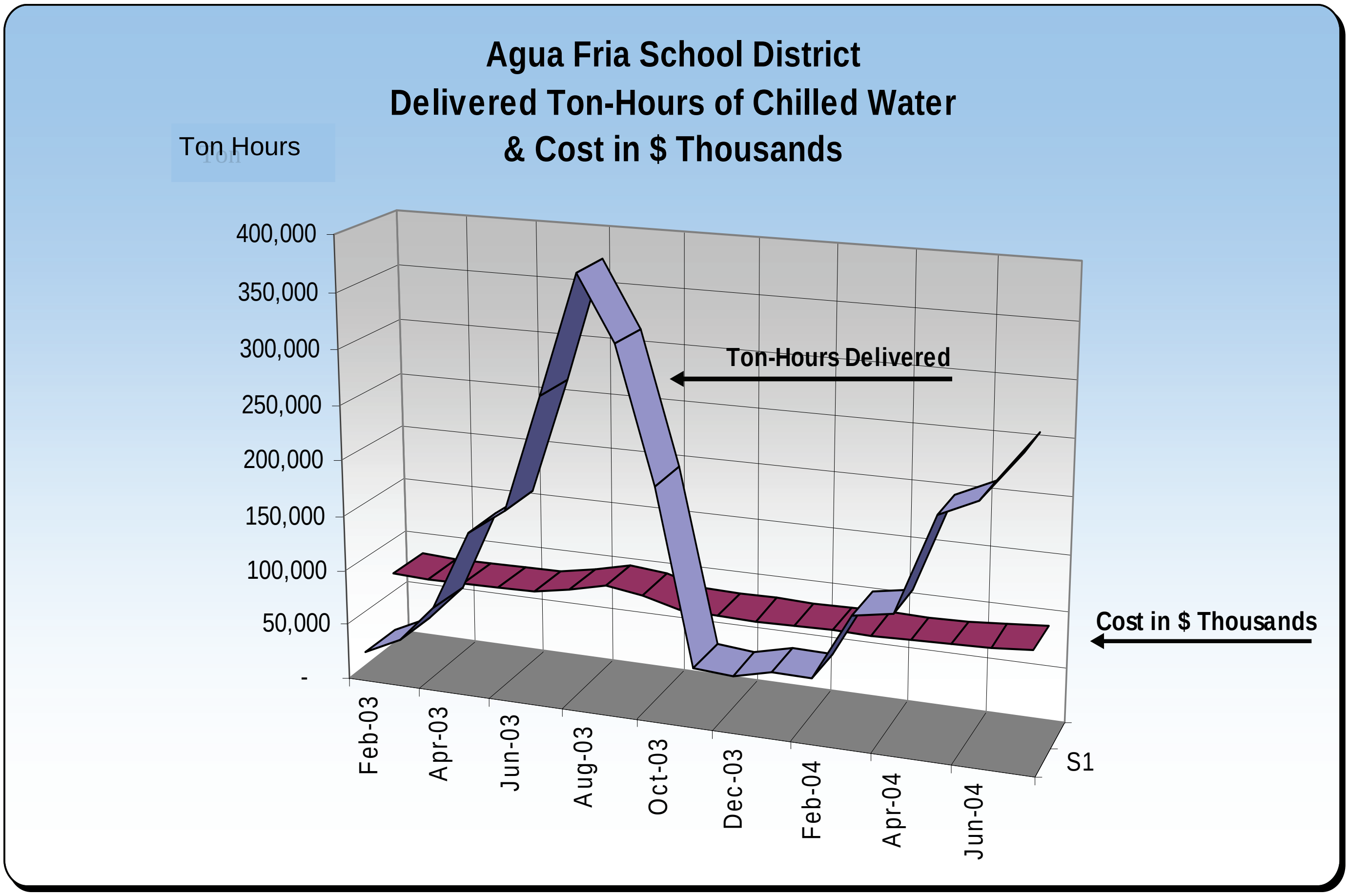
APPENDIX B-2

Agua Fria School District Square Footage & kW Demand by High School



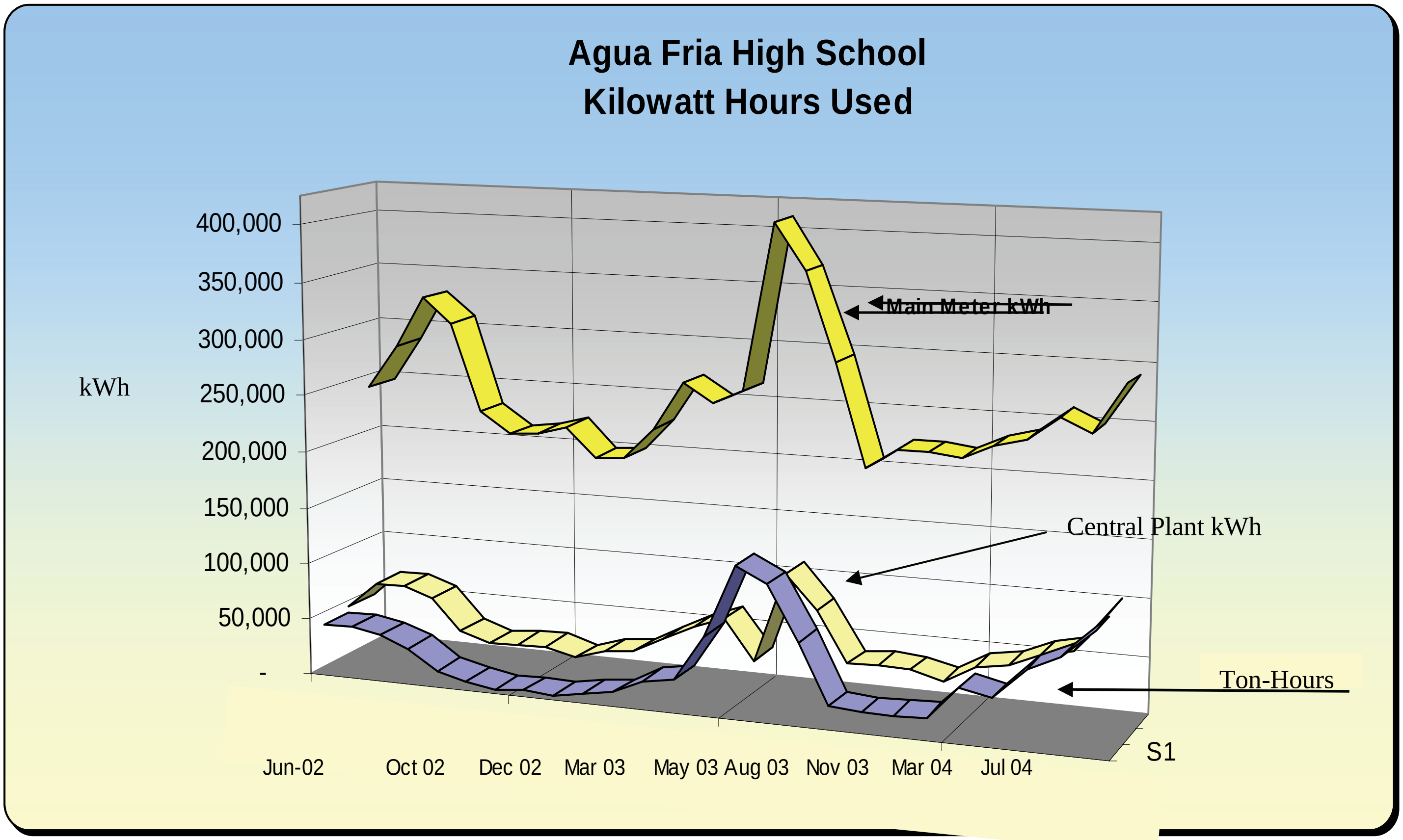
APPENDIX C

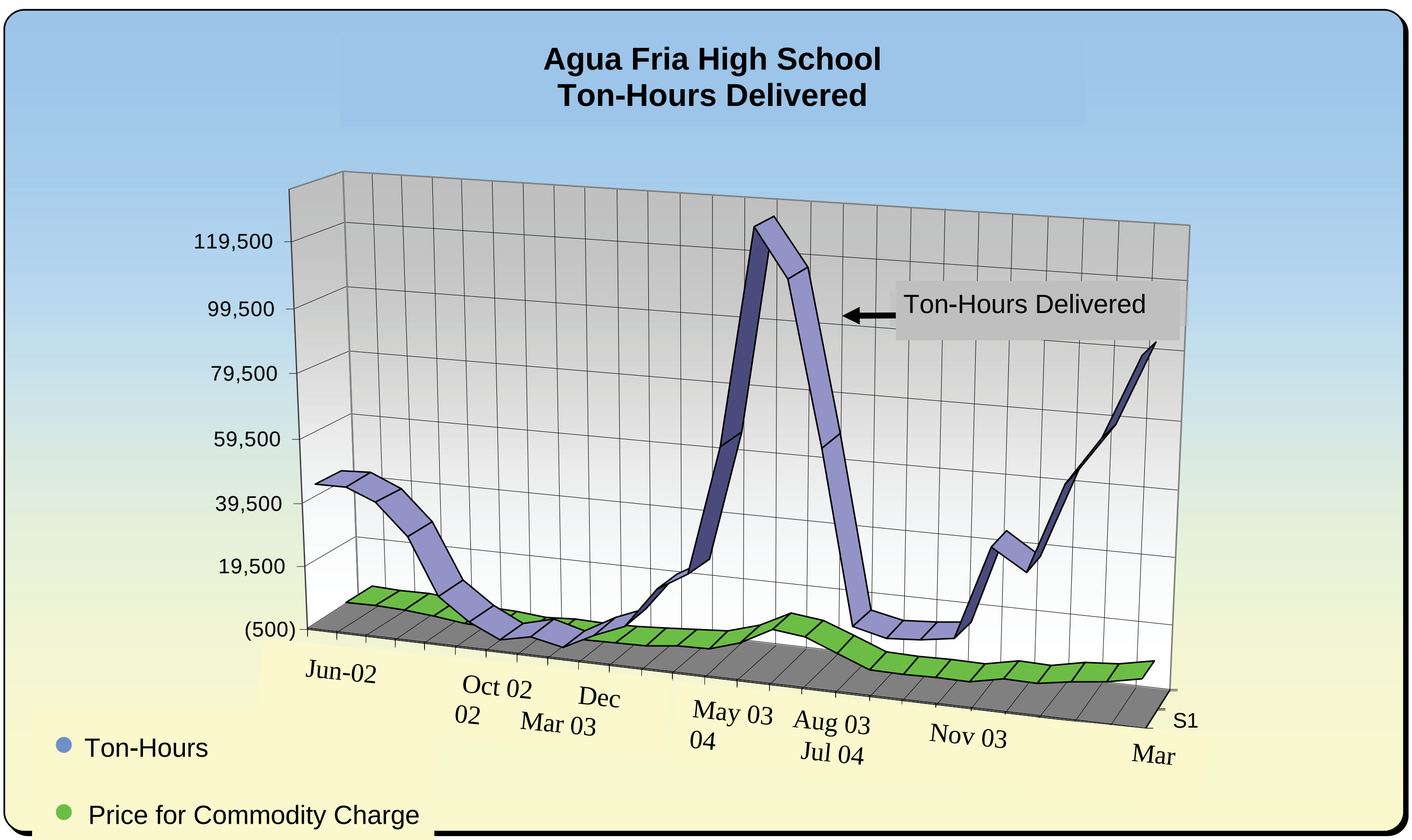
Summary of Agua Fria Outsourced Commodity Use



APPENDIX D-1

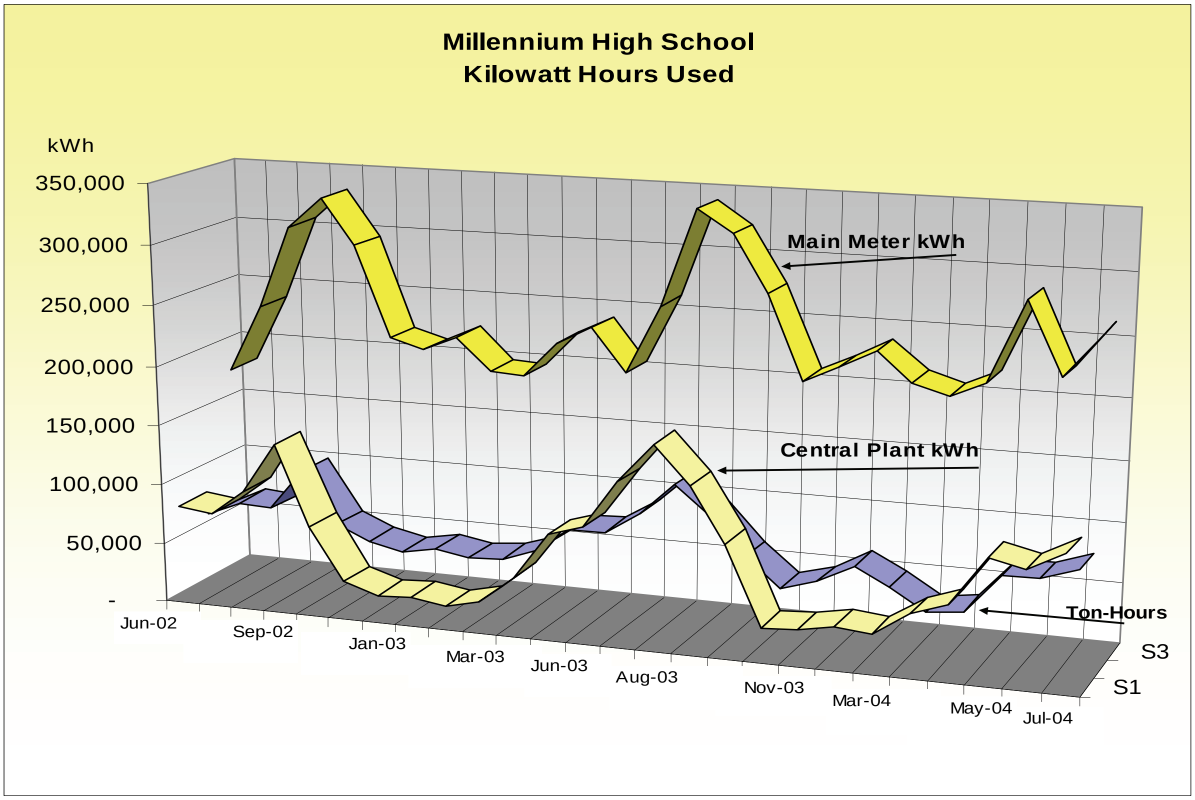
Summary of Energy Use at Agua Fria High School

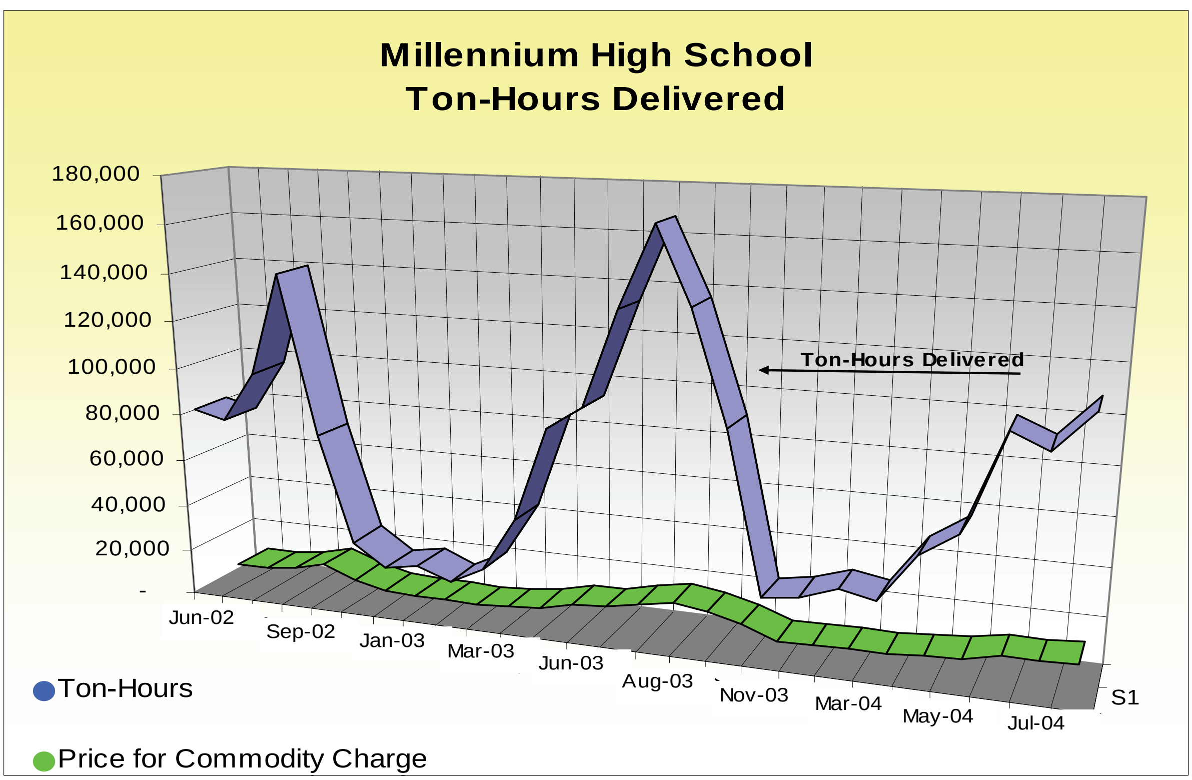




APPENDIX D-2

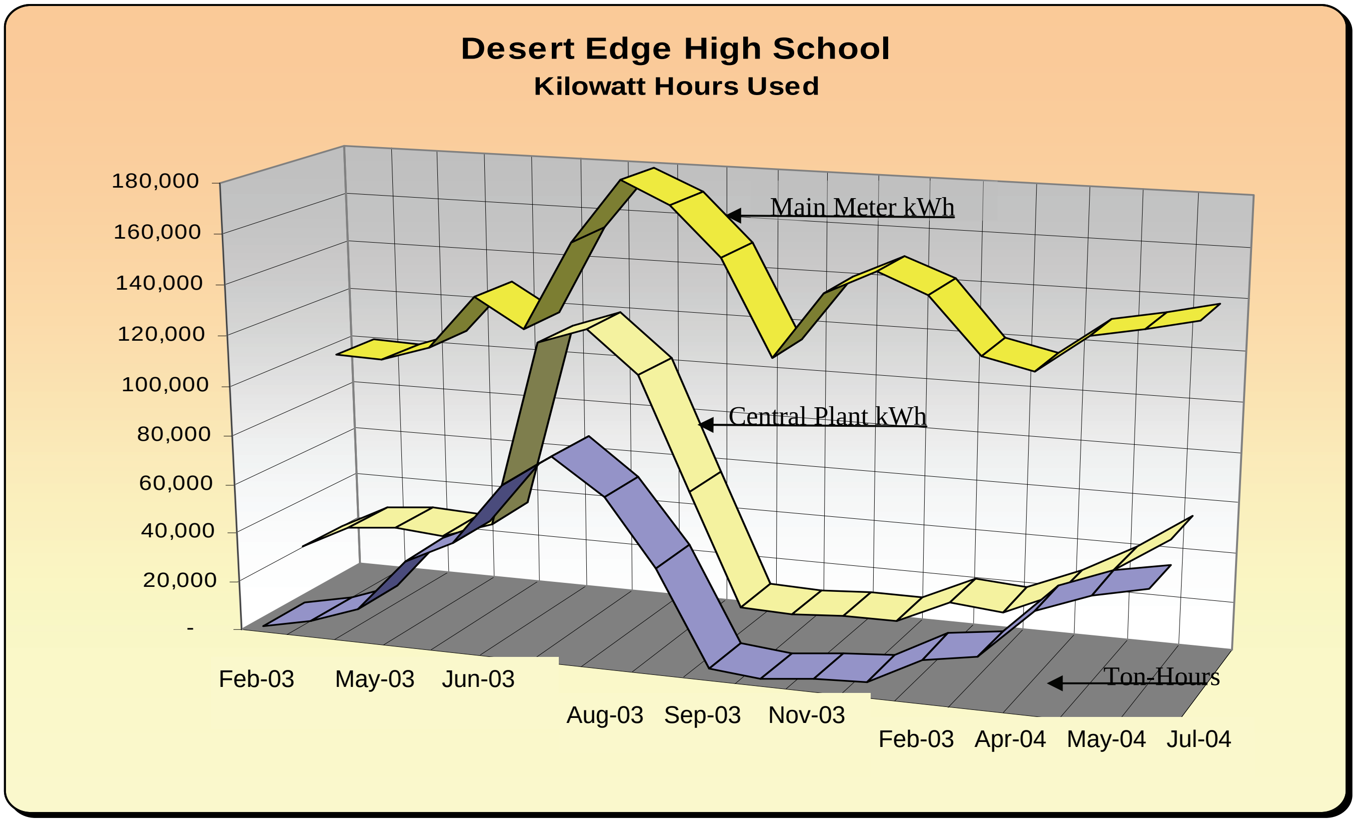
Summary of Energy Use at Millennium High School

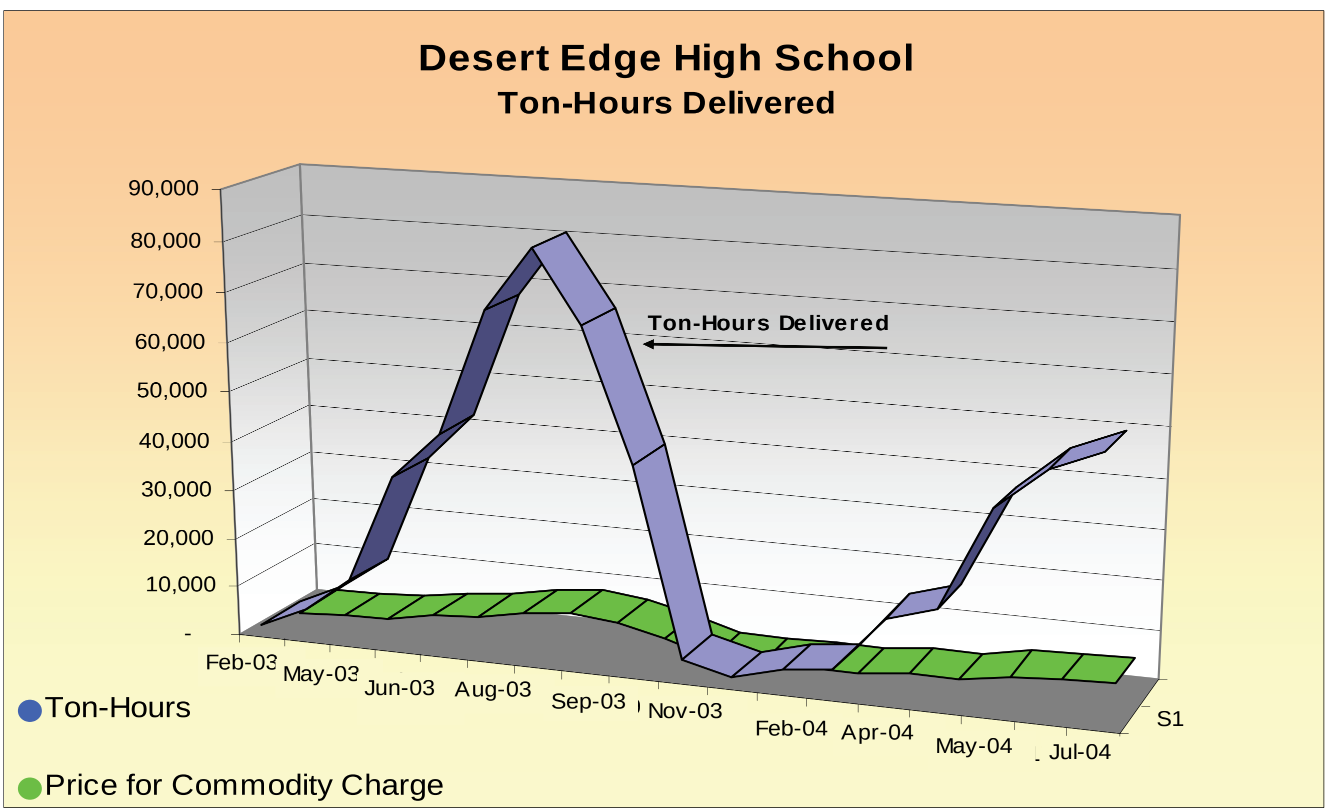




APPENDIX D-3

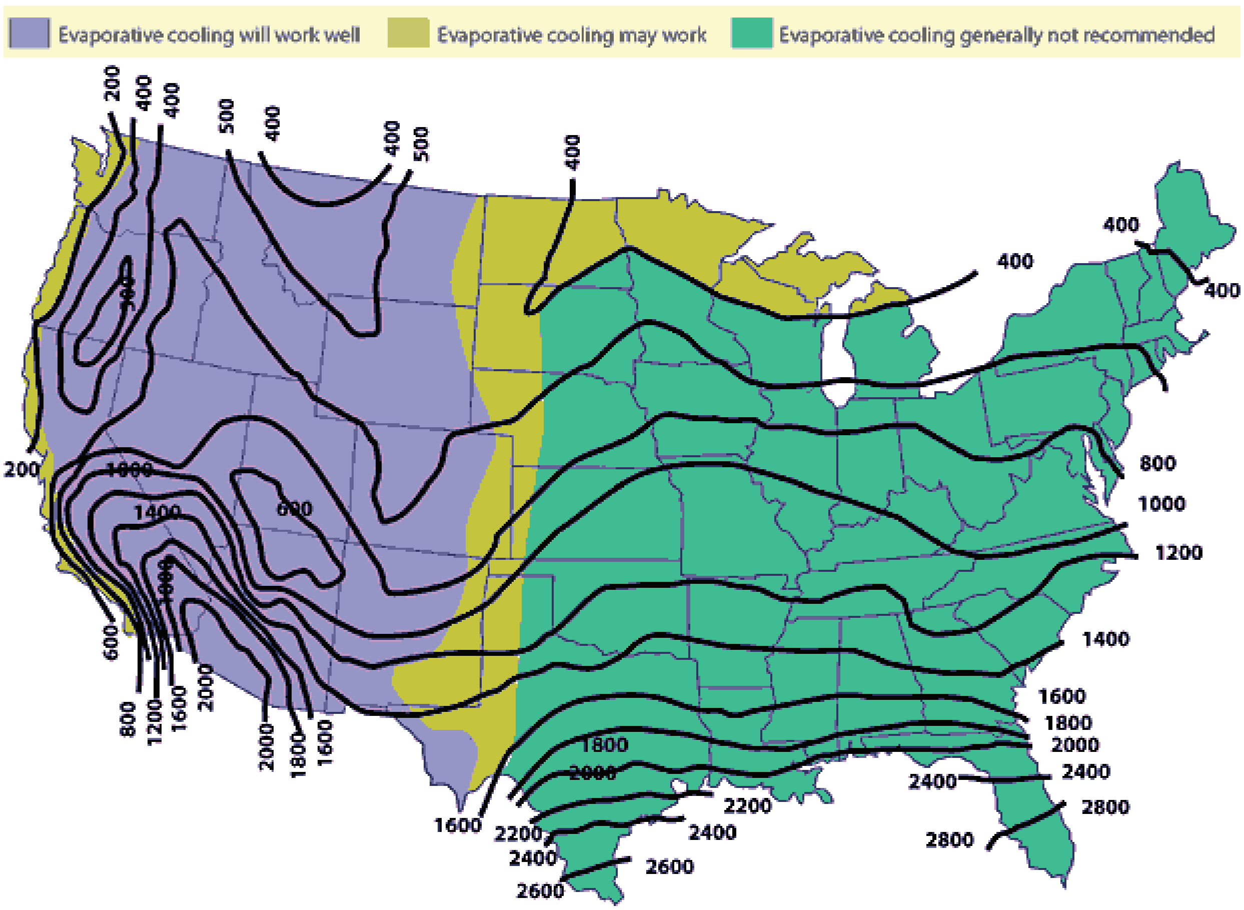
Summary of Energy Use at Desert Edge High School





APPENDIX E-1

Map of Summer Cooling Load Hours & Cooling Degree Days



Map of Summer Cooling Load Hours

Reprinted from pages 16 and 17 of the ARI Unitary Directory, August 1, 1992 - January 31, 1993
Courtesy of the Air-Conditioning and Refrigeration Institute, ARI.

Cooling Degree Days

Phoenix

	2004	2003	2002	2001	2000	1999	1998	1997	1996
January	6	8	0	0	6	0	0	0	0
February	1	6	19	0	7	7	0	0	41
March	281	79	89	112	60	68	50	185	71
April		179	359	250	321	138	136	278	278
May		576	525	685	624	468	361	639	547
June		810	858	816	789	724	619	689	817
July		1,023	971	920	939	884	924	901	955
August		924	940	928	867	875	928	885	916
September		779	748	823	764	679	691	761	584
October		556	325	452	259	453	295	322	359
November		20	82	177	0	199	13	61	63
December		4	0	0	0	1	2	0	4
Annual Total	288	4,964	4,916	5,163	4,636	4,448	4,019	4,721	4,635

APPENDIX E-2

Economics of New Chiller Performance

Table 1. Chiller Efficiency Recommendations (kW/ton)

Chiller Size	ASHRAE Full Load	ASHRAE IPLV	FEMP Full Load	FEMP IPLV
150-300 tons	0.84	0.78	0.59	0.52
Over 300 tons	0.68	0.66	0.56	0.44

Table 2. Economics of New Chiller Performance

	Standard Efficiency (ASHRAE)		High Efficiency (FEMP)			
Annual Hours of Operation	Annual kWh	Annual Cost	Annual kWh	Annual Cost	Annual Savings	Simple Payback (Years)
1000	148,500	$19,899	99,000	$11,682	$8,217	3.7
2000	297,000	$30,294	198,000	$18,612	$11,682	2.6
3000	445,500	$40,689	297,000	$25,542	$15,147	2.0
4000	594,000	$51,084	396,000	$32,472	$18,612	1.6
5000	742,500	$61,479	495,000	$39,402	$22,077	1.4
6000	891,000	$71,874	594,000	$46,332	$25,542	1.2
7000	1,039,500	$82,269	693,000	$53,262	$29,007	1.0
8000	1,188,000	$92,664	792,000	$60,192	$32,472	0.9

Assumptions: Energy costs 7 cents per kWh, electrical demand charges are $12 per kW for three months of year, chillers operate at 75% average load, and the first cost premium for a high-efficiency 300-ton chiller is $30,000 over a standard chiller.

Washington State University Cooperative Extension Energy Program. WSUCEEP00-138

APPENDIX F-1

Schools With District Heating & Cooling

Creighton University-Administration Building
Energy Systems Co.
Omaha, NE
71,035 square foot – cooling

Neurosciences Research Building
The University of North Carolina at Chapel Hill
Chapel Hill, NC
108,380 square foot – heating, cooling, process use, domestic hot water, refrigeration

Administration Building
University of Idaho
Moscow, ID
32,500 of 121,500 square foot – cooling

Agricultural Sciences
University of Idaho
Moscow, ID
55,000 of 111,400 square foot – cooling

Hume-Fogg Academic High School
Nashville District Energy System
Nashville, TN
180,000 of 200,000 square foot—heating & cooling

Idaho Commons
University of Idaho
Boise, ID
150,000 square foot—heating, cooling, process use, domestic hot water

Administration Building

Agricultural Sciences

Huntsman Hall – University of Pennsylvania Wharton School

Hume-Fogg Academic High School

APPENDIX F-2

Schools With District Heating & Cooling

Arizona State University I and II Bio Science Buildings
Northwind Phoenix LLC Phoenix, AZ
342,000 square foot – heating, cooling

Tennessee State University
Nashville District Energy LLC, a wholly owned subsidiary of Constellation Energy Source Nashville, TN
200,000 square foot – heating

Omaha Central High School
Energy Systems Co.
Omaha, NE

Broadway Residence Hall
Columbia University
New York, NY
Square foot not provided– heating, cooling, domestic hot water, refrigeration

University of St. Thomas Law School
NRG Energy Center Minneapolis
Minneapolis, MN
151,000 square foot – heating

Johns Hopkins University/Downtown Campus
Comfort Link Baltimore, MD
60,000 square foot—cooling

Student Recreation Center

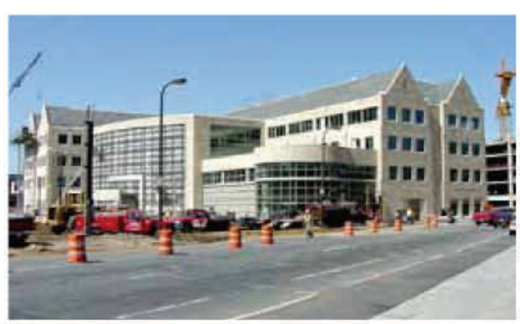
Student Union Building
University of Idaho
Moscow, ID
60,000 of 109,300 square foot—Cooling

WMEP Interdistrict Downtown School
NRG Energy Center Minneapolis
Minneapolis, MN
70,000 square foot—Cooling

Huntsman Hall – University of Pennsylvania Wharton School
Trigen-Philadelphia Energy Corp. Philadelphia, PA 320,000 square foot –heating, cooling

J.A. Albertson Building (College of Business and Economics)
University of Idaho
Moscow, ID
55,000 square foot – heating, cooling, domestic hot water, snow melting

Student Union Building



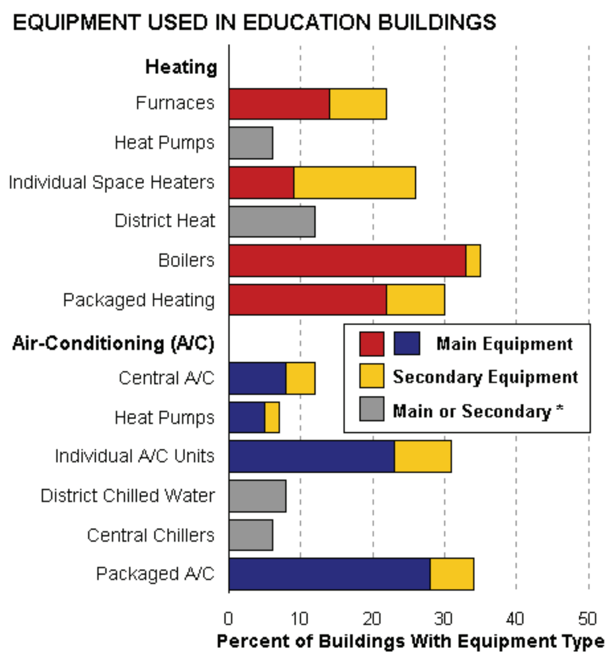
Courtesy of University of St. Thomas.

University of St. Thomas Law School

APPENDIX F-3

Schools With District Heating & Cooling

Heating and Cooling Equipment



* These equipment types could not be separated into main and secondary because data was withheld for main and/or secondary (either data was reported for fewer than 20 sampled buildings or the relative standard error for the estimate was greater than 50 percent).
Note: Secondary equipment category includes buildings that used equipment equally and did not have a main equipment.
Source: Energy Information Administration, 1995 Commercial Buildings Energy Consumption Survey.

Creighton University

Arizona State University I & 2 Bio Science Building

Creighton University (27 buildings)
Energy Systems Co.
Omaha, NE
2,467,381 square foot – heating, cooling, domestic hot water

Liberty Elementary School
Energy Systems Co.
Omaha, NE
77,000 square foot – heating, cooling (heat pump loop)

Living Learning Community (5 buildings)
University of Idaho
Moscow, ID
113,120 square foot – heating, cooling, domestic hot water

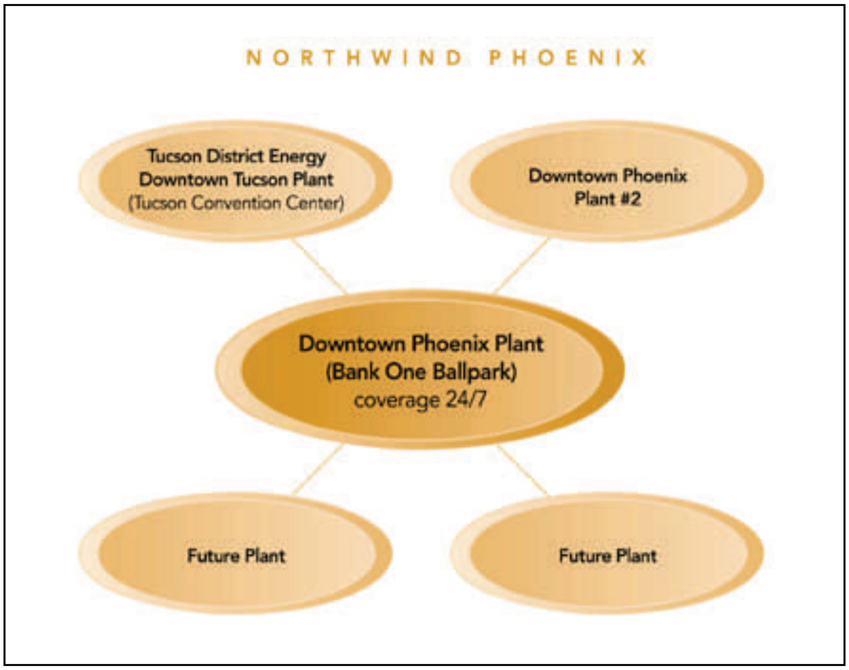
The University of Akron Arts & Science Building
Akron Thermal, Limited Partnership
Akron, OH
127,111 square foot – heating

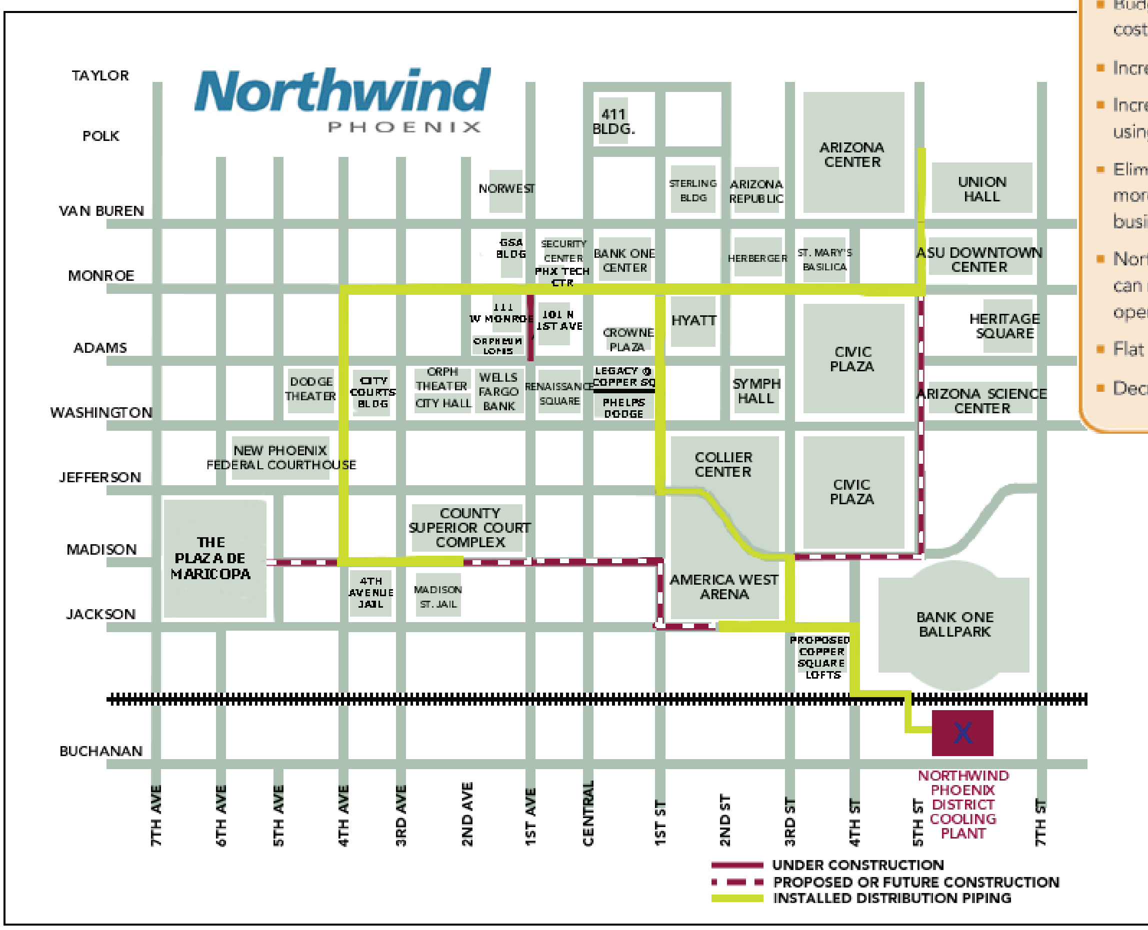
GondaCenter
University of California, Los Angeles
Los Angeles, CA
125,202 square foot—heating, cooling, domestic hot water, refrigeration, lab equipment, autoclaves

Opus Hall – University of St. Thomas
NRG Energy Center Minneapolis, LLC
Minneapolis, MN
98,200 square foot—cooling

APPENDIX G

Northwind Phoenix District Heating & Cooling





"We are excited about what this project will mean to Bank One Ballpark and all of downtown Phoenix," explains Rich Dozer, President of the Arizona Diamondbacks. "When the Ballpark was built, we projected additional economic benefits would flow to downtown as a result of the stadium's construction. This cooling system is one prime example."

Additional benefits realized by Northwind Phoenix's District Cooling Service:

- Eliminate initial capital costs of cooling equipment
- Budget predictability by eliminating costly equipment repairs
- Increased reliability
- Increased energy efficiencies using lower water temperatures
- Eliminate maintenance duties — more time can be focused on core business functions
- Northwind's dedicated fiber link can monitor and control building operations 24/7
- Flat electric profile
- Decreased electricity costs