They Why's of LED: Lighting in K-12 Education

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ASG ENERGY

[Illuminating Savings]

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The Why's of LED Lighting in K-12 Education

- Why - Protecting Student's Health and Well Being
- Why - LED Lighting as a Cost Reduction Strategy
- Why - Our School District
- Why - Consider Financing Options

Why – Protecting Student's Health and Well Being

WHY – Protecting Student's Health and Well-Being

Lighting can have many positive, and unfortunately, negative impacts on student health and well-being.

- Some of the benefits of LED lighting in schools are . . .
  - The improvements of school safety.
  - The reduction of eyestrain and other difficulties associated with lighting.

Harmful Contaminants

- Installing LED light fixtures can reduce the risk of exposure to harmful contaminants such as Polychlorinated Biphenyls (PCBs).

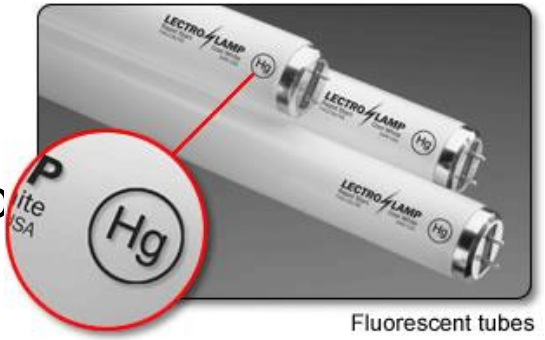
  - According to the U.S. Environmental Protection Agency (EPA), PCBs are carcinogens that can lead to negative health effects on the immune and nervous systems and can be found in the magnetic T12 fluorescent ballasts.

  - These ballasts can leak or rupture, but some can even emit some small amounts of PCBs throughout normal use of the fixture.

  - Schools in the United States that were built before 1979 may still have PCB-containing T12s.

  - Exposure to these contaminants occur when the contaminated air is breathed in or contaminated materials are touched after a leak or rupture.

Harmful Contaminants - Continued



Fluorescent tubes

- Another harmful contaminant contained in outdated lighting techno mercury.
  - Fluorescent lighting contains combinations of mercury and inert gases when the current runs through the tube.
  - Depending on the type of exposure, mercury can enter the body through the lungs or skin.
  - In the event of a shattered fluorescent tube, anyone is prone to mercury contamination; making fluorescent tubes a safety hazard in school facilities.
- Another hazard of mercury is its production of UV light.
  - UV radiation can cause damage to tissues in our eyes and skin.
  - Too long of exposure to UV radiation can cause cataract formation and can also contribute to macular degeneration.

Light Quality

- Many students who enter school already have visual problems—i.e. focusing, eye tracking, lazy eye, strabismus, etc.

  - It's important to not make it more difficult for those students to properly see all areas of the classroom as well as ease of navigating the rest of the school.

  - Glare can cause students and teachers to squint, blink or look away.

  - Lighting quality, such as the luminance, will impact . . .
    - Visual performance
    - Comfort

Light Quality - Continued

- Fluorescent lighting has also been shown to bother students with autism.

  - People with autism tend to have sensitivity to the sub-visible flicker of direct fluorescent lighting. This can cause headaches, eyestrain and increased repetitive behavior.

  - Unlike fluorescent lighting LEDs do not flicker when fully dimmed, making them a great option for special education classrooms.

Light Quality - Continued

- Color temperatures also play a huge role in the health of students.

  - Studies have shown that cool color temperatures (4100K – 5000K) can improve the behavior of students who are hyperactive or have learning disadvantages.

  - The cool light color helps them focus and concentrate on tasks and projects.

  - Hyperactivity is also related to a radiation stress condition and the radiation emitted from fluorescent lighting fixtures can make it worse.
    - When exposure to this radiation is reduced, behavior and performance can improve.

Circadian Rhythm

- An important biological function that depends on proper lighting is our circadian rhythm.

  - It helps our bodies determine when to wake up, when to go to sleep, and even when to concentrate and when to relax.

  - Without proper lighting that matches our circadian rhythm, our sleep-wake cycle can get thrown off.

  - Students who aren't getting enough sleep will not be able to perform to their full potential in the classroom.

Psychological Stability for Students

- LED lighting properly can boost focus, assist in concentration and relaxation, and improve overall mood and behavior in students.

  - Circadian rhythm not only has an impact on student productivity and physical health, but it also impacts mental health.
  - Cooler color temperatures in the morning hours will help students wake up and focus on their schoolwork.
  - Helping students become more alert will help their mental cognition and ability to learn and comprehend material.

Psychological Stability for Students – Cont.

- Like color temperatures, light levels are also very important in the classroom.
  - Bright lighting is used to treat various types of depression including Seasonal Affective Disorder (SAD) or the "winter blues".
  - This happens usually during the winter months when people aren't exposed to enough sunlight during the day and is very common in school and office environments.
  - Spending too much time in a dimly lit room can negatively affect mood and cause someone to feel depressed.
- Bright lighting is useful for depression treatments—it helps encourage bright and cheery moods.
  - Dim lighting can also negatively impact what information is received and stored in the brain.
  - If it is too dim to read, the wrong information might be read and sent to the brain.

Psychological Stability for Students – Cont.

- Studies have shown that artificial lighting that simulates daylight can increase concentration and cognitive performance in students.

  - These studies have found that the lighting provided stimulation to the body that mimicked being outdoors. To help students become more alert earlier in the day, this caused their circadian rhythms to shift forward (in time).

  - It was reported some students were able to tell a difference in their mood and concentration.

  - Daylighting has also been shown to improve mood, mental performance, alertness and brain activity, while decreasing depression, stress, sadness and violent behavior.

Creating a Productive Learning Environment

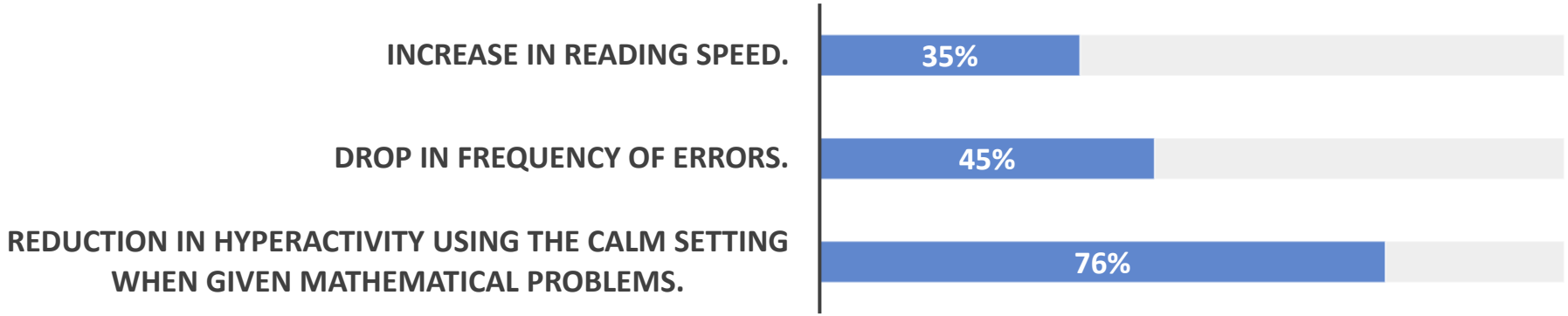
- Proper lighting in schools can have numerous positive impacts on student productivity.
  - ➢ It can create a more effective learning environment, which can lead to improved test scores, enhanced learning and increased overall student productivity.
- Color temperature can impact students' visual skills—this directly influences academic performance.
  - ➢ Students should be able to switch between areas in the room without any visual interruption or changes due to lighting.
- Adjusting the classroom lighting throughout the day will also help match students' biological clocks and keep them productive.

Markwort Study

- A study conducted by Dr. Michael Schulte-Markwort, Director of the Clinic for Psychosomatics in Children and Juveniles at the University Medical Centre Hamburg-Eppendorf, studied 166 children, ages 8-16 and 18 teachers to determine the effect of light on learning behavior.

- Teachers had four light control options:
  - ***NORMAL*** – for regular classroom activities
  - ***ENERGY*** – to invigorate when children need to be more active
  - ***FOCUS*** – aid concentration during challenging tasks
  - ***CALM*** – to relax during individual work or quiet time

- The study found that these lighting control settings had great results on the students:



Conclusion:
WHY – Protecting Student's Health and Well-Being

- Learning and development occur in stages, and lighting can play a huge role in those stages: physical, cognitive and socio-emotional development.
  - Starting with motor skills, moving toward how our brain functions and then establishing a sense of self and relationships with other people.
  - Lighting affects multiple areas of our lives; it shapes how we sleep, our mood, and our motivation and concentration.
- That's why it's vital to pay close attention to the lighting in schools and change those lighting systems to improve the lives of today's students.

Why - LED Lighting as a Cost Reduction Strategy

WHY – LED Lighting as a Cost Reduction Strategy

- According to the Department of Energy, U.S. school districts spend approximately $8 billion annually on energy costs, more than they spend on textbooks and computers combined.
  - Aside from salaries and benefits, energy costs are the second largest operating expense for school districts.
  - It is estimated that $2 billion of this total can be saved by improving energy efficiency in K-12 schools.
- As a result, school districts who invest in energy efficiency programs can achieve significant energy cost savings, along with environmental, economic and educational benefits.
  - For most educational environments, lighting, cooling and plug loads (computers and copiers) account for more than 70% of electrical use.
  - Using less energy than any lighting technology on the market, **LEDs will cut energy and maintenance costs drastically**.

LED Lighting as a Cost Reduction Strategy – Continued

- On the bright side, energy is one of the few expenses that can be decreased without negatively impacting classroom instruction.
  - Many of the education facilities throughout the United States still operate using fluorescent, or even incandescent, lighting that utilizes more energy than LEDs.
  - Furthermore, additional expenses are incurred in cooling expenses trying to compensate for the heat generated from fluorescent fixtures.
  - These expenses could be used towards other areas of the facility that need more attention.

- ***An LED lighting upgrade could reduce overall energy the facility uses for lighting by 50 to 75 percent. Plus incorporating controls, such as occupancy sensors and daylight harvesting, can increase the savings even more.***

Case Study: North East Independent School District

Background

- ASG Energy, was retained by North East Independent School District (NEISD) to assist with lighting efficiency upgrades.

  - NEISD is the second largest School District in San Antonio and serves a population of 67,000 students.

Project Summary

- This particular project focused on converting the existing lighting to LED lighting across 10 school campuses.

  - Combined, these 10 schools consist of 1,070,641 square feet and this project involved retrofitting approximately 11,000 interior fixtures.

Case Study: North East Independent School District - Continued

LED Lighting Energy Savings Analysis

- ASG Energy conducted a post measurement and verification analysis based on the energy usage data for the same time period for the previous year.

  - Pre & Post Measurement 3-Month Periods:
    - September – November (Pre LED-Installation)
    - September – November (Post LED-Installation)

	Energy Cost: 3-Month Period
Pre-LED Install	$348,394.28
Post-LED Install	$280,037.70
Actual 3-Month Savings	$63,356.58
Daily Savings*	$706.28
Est. Annual Energy Savings**	$257,792.06

NOTE:
*Based on actual billing days for each individual school during pre and post measurement periods.
** Estimated annual savings is based on the actual calculated daily savings for the 3-month pre and post measurement period.

Case Study: North East Independent School District - Continued

LED Lighting Savings Analysis

NEISD: 10 School Campuses	
Estimated Annual Energy Savings	$257,792
Est. Annual Maintenance Savings	$52,295
Estimated Total Annual Savings	$310,087
Total Project Cost	$1,823,835
Est. Rebate Amount	$300,000
Net Project Costs	$1,523,835
Payback Period	4.91 Years
Estimated 10-Year Savings	$3,100,870

NEISD receiving a utility rebate check for over $300,000 for LED Lighting upgrade.

Environmental Impact

This LED conversion prevented approximately **2,854 metric tons** of CO_2 greenhouse gasses from being released into the environment, which is equivalent to removing 611 passenger vehicles from the road for one year

Why - Our School District

WHY – Our School District?

Overall Benefits of LED Lighting

1. **Energy Savings**

   a. LED lights only require about 25% of the energy of incandescent bulbs which results in significant savings in monthly utility bills.

   b. An additional benefit will be the reduction of air conditioning expense, as halogen and incandescent bulbs generate heat and are less energy efficient, and LEDs are very cool.

      - According to ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers), their guideline states that 30 to 35 watts of cooling is required to offset the heat output for every 100 watts used to light a space.

2. **Long Life and Maintenance Savings**

   a. LEDs have a longer operational life and therefore require less maintenance.

      - For example, a typical T8 fluorescent lamp has a 20,000-rated life and an LED equivalent will have a 70,000 hour rated life.

WHY – Our School District? (Continued)

Overall Benefits of LED Lighting

3. **Utility Company Rebates**
    a. Utility companies offer incentives for businesses to reduce power consumption by switching to LED lighting.
    b. Here is a great resource to find out what's available where you live: http://www.dsireusa.org/
4. **Better Facility Management**
    a. LED lighting and controls provide a comfortable and productive visual environment while effectively monitoring energy consumption by controlling the lighting.
    b. Reduction of maintenance costs related to changing of lamps and bulbs.
5. **Instant Lighting and Frequent Switching**
    a. Switching LED lighting on/off frequently does not affect their usable life or light emission.

WHY – Our School District? (Continued)

Overall Benefits of LED Lighting

6. **Environmental Benefits**
    a. LED lights are free of toxic chemicals as most conventional fluorescent bulbs contain mercury.
    b. Another issue with the fluorescent bulb is the disposal as they have traces of mercury and require special care.
    c. There is no health risk if an LED happens to break due to the fact it is a solid-state object.
7. **Improved Quality of Light**
    a. Administrators, teachers and students also experience some health benefits. LEDs don't flicker like fluorescents can, leading to a more comfortable environment and fewer complaints about headaches or eye strain.
    b. LED lighting can improve security and safety with the efficiency, long life and weather resilience by keeping the lights on.
    c. LED lighting surpasses other technologies at rendering the true color of environments they illuminate, based on industry-standard Color Rendering Index (CRI) and R9 test methods.

Why - Consider Finance Options

WHY – Consider Financing Options?

- Even if the short- and long-term benefits of energy-related improvements are obvious, upfront capital for projects can require effort to access and must be balanced against competing capital needs.
  - ➢ School administrators face challenges in getting approval from local voters to spend tax dollars on energy-related improvements.
- There are a range of innovative financing approaches that lower the upfront costs of these investments, financing can be complicated.
  - ➢ Successful projects also require dedicated staff time and attention to get off the ground and to maintain and monitor the savings over time.

WHY – Consider Financing Options? (Continued)

- There are various options available to fund the capital required to become a high-performance school:

1. Internal Cash
2. Grants
3. Bonds
4. Leasing
5. Energy Services Agreements

Internal Cash

- Internal financing is the simplest, most flexible and most direct way to pay for energy-related improvements.

  - However, the availability of internal funds is constrained by budget limitations and competing operating and capital investment needs.

  - Using internal financing normally requires that funds be approved within a school's annual operating and capital budget-setting process.

  - Budget constraints, competition among alternative investments and the need for high rates of return can significantly limit the number of internally financed energy-related improvements.

Internal Cash Monies from Existing School Budgets	
Pros	**Cons**
☐ Extremely flexible capital ☐ Not debt, so no interest or obligations to repay	☐ Significant competing needs for these flexible funds ☐ Most school districts lack sufficient cash to fund all (or any) Energy Efficiency /Renewable Energy needs

Grants

- Grants offer another funding solution – they're external sources of capital that neither schools nor their taxpayers need to re-pay.

  - Grants can help to lower the overall cost of school energy-related improvements (in some cases to $0), enhancing project economics.

  - However, accepting a grant does obligate the school to perform actions specified in the grant agreement (i.e. install high-efficiency measures to code).

Grants **Monies from Third Parties** (Federal & State Governments, Utilities, Foundations that cover all or partial costs of energy improvements.)	
Pros	**Cons**
☐ Best source of funds – reduces total project costs ☐ Not debt, so no interest or obligation for school district or taxpayers to repay	☐ Limited availability ☐ Restricted uses ☐ Often covers only part of project costs ☐ Philanthropic and government grants require planning and often a detailed proposal

Bonds

- Municipal bonds are long-term debt obligations issued to finance construction and/or improvements to public infrastructure like town halls, schools, streets and waste treatment facilities.

  - Municipal bonds require the issuer to make scheduled interest payments at specific periods at an agreed-upon rate and to return the principal on the date the issue matures (or incrementally throughout the life of the bond).

  - They vary by the process school districts must go through to access them as well as the bond holder's recourse should the issuer fail to make debt service payments (i.e. the underlying bond security).

Bonds Debt secured by the obligation to levy and collect property taxes sufficient to pay annual debt service.	
Pros	**Cons**
☐ Flexible capital for funding a range of clean energy projects (often subject to voter approval) ☐ Lowest cost debt due to robust security and tax-exempt interest ☐ Increased revenue for school district in most cases because taxpayers repay debt ☐ Long terms (20-30 years)	☐ Voter approval required (in most cases) ☐ Counts against statutory debt limit restrictions ☐ High fixed issuance costs, including obtaining a legal opinion, setting up a trustee, and retaining accounting services ☐ Long development time (approximately 9+ months) to prepare package of funding requests and gain voter support

Leasing

- Leasing energy related improvements, especially the use of tax-exempt lease-purchase agreements for energy efficiency equipment, is a common and cost-effective way to finance the improvement and then use the energy savings to pay for the financing costs.

- Leases often have slightly higher rates than bond financing and require the school district (instead of the taxpayers) to repay the debt.

- Leases are a faster and more flexible tool than many other options, including bond financing, and can be an important tool for K-12 school districts.

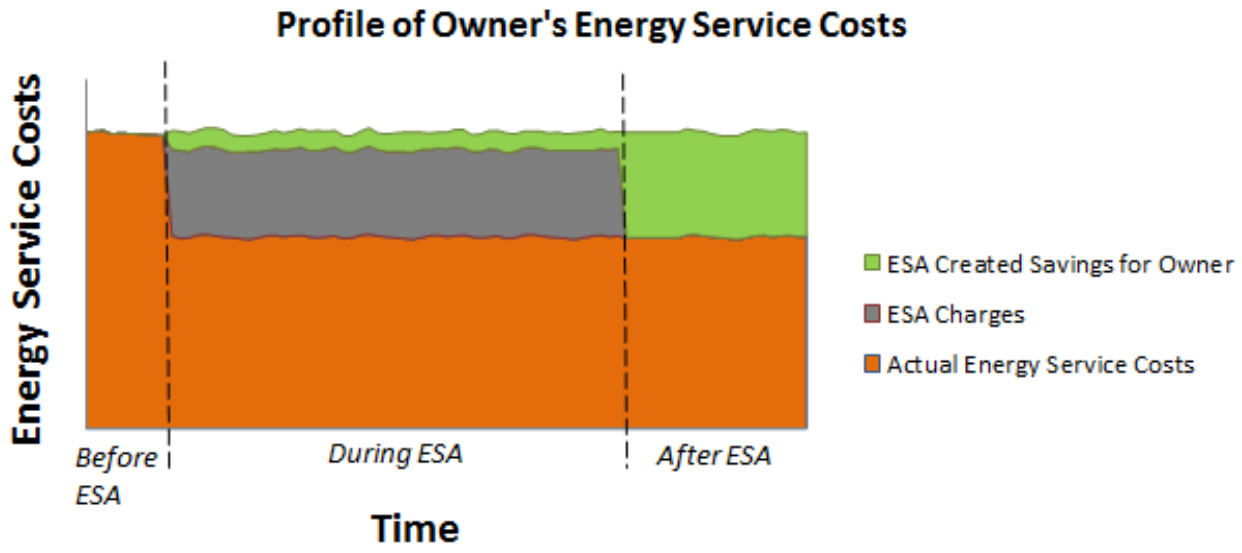
- When properly structured, this type of financing makes it possible for public sector agencies to draw on dollars to be saved in future utility bills to pay for new, energy-efficient equipment and related services today.

Leasing Arrangements School district leases property from a lessor, the underlying security is the leased equipment or real estate.	
Pros	**Cons**
☐ Often voter approval not required ☐ Often no subject to debt limitations ☐ Flexible capital for funding a range of Energy Efficiency projects ☐ Tax exemption lowers costs ☐ Flexible terms (5-15 years) ☐ Short development time (3 months)	☐ School district (not taxpayers) must repay the debt. ☐ Higher interest rates than bond debt ☐ Reserve fund and capitalized interest typically required

Energy Services Agreements (ESAs)

- Energy Services Agreements (ESAs) are performance-based contracts through which a service provider agrees to finance, develop and deploy energy efficiency/renewable energy projects for clients without any upfront capital expenditures.

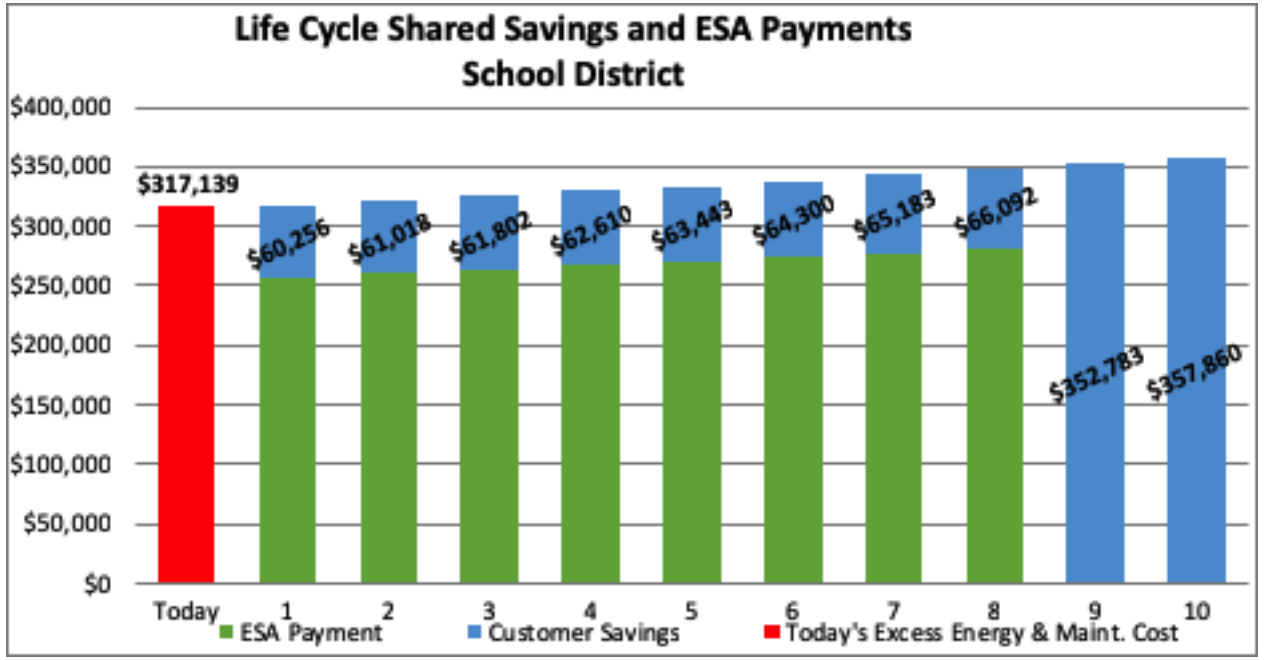
  - Through this financing model, the client agrees to pay back the project costs through energy savings realized on utility bills over the ESA term.
  - Savings occur immediately after the energy efficiency project is online and are usually measured in kilowatt-hours (kWh) of electricity and therms of natural gas.
  - At the end of the ESA term, after the full costs of the project have been paid off through energy cost savings, the customer retains all of the savings and continues to pay lowered utility bills.
  - The ESA provider may also agree to be responsible for providing ongoing maintenance, upgrades and improvements to ensure the project's continued success.
  - ESA providers assume the risk that savings will occur to justify the investment by providing performance guarantees.



ESA Scenario: School District (Continued)

- This innovative ESA provides a turnkey project funding option.

  - The chart to the right provides a graphical representation of an 8-School campus current excess utility and maintenance costs, estimated annual ESA payments, and estimated annual energy and maintenance savings.
  - Under this 8-year ESA, the ESA provider provides all of the up-front funding, and will design, build, service, maintain and own the energy efficiency systems.
  - The School's monthly ESA payments are fully funded out of the savings created by the project and the remaining saving will reduce operating costs.
  - This assumes a fair-market-value of zero at the end of the term.



The Why's of LED Lighting in K-12 Education

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Now What? Where to Begin?

It Starts with the Data!

Benchmarking Electrical Energy Usage in Schools

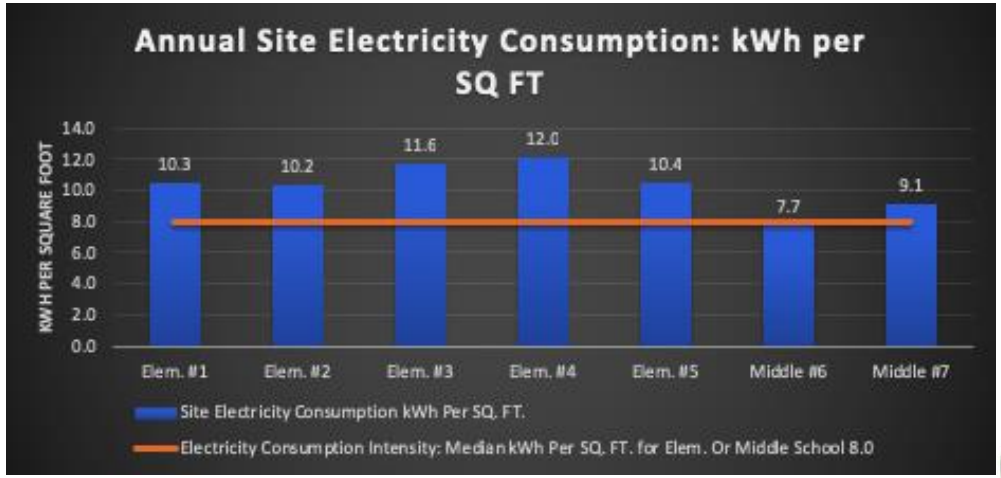
- **Where do we start?**
  - This is one of the most common questions when discussing LED Lighting with School Districts.
  - While it is fairly easy to identify exterior lighting and school gymnasiums as “low hanging fruit” and good candidates to start with LED conversions, there are some additional benchmarking analysis that school districts can do in order to help identify and prioritize where to start.
- One of the benchmark analysis ASG Energy recommends taking School Districts through is evaluating their annual kWh electrical consumption across each school property and evaluating the kWh consumption by square foot.
  - This establishes a kWh consumption per square foot that can then be used to benchmark against other data sources, such as the Commercial Buildings Energy Consumption Survey (CBECS), in order to identify school properties that may potentially be energy inefficient, which could include lighting.

Benchmarking: Start with the Data

- As a result of conducting this type of benchmark analysis, school districts can then begin to prioritize and look at additional variables (i.e., age of school, plug loads, HVAC equipment, etc.) that may be impacting energy usage.

- Furthermore, this can be followed up with additional energy modeling, a lighting audit and economic analysis in order to develop a comprehensive LED Lighting Conversion Economic and Energy Analysis.

School	SQ FT	Annual Electrical Consumption (kWh)	Site Electricity Consumption kWh Per SQ. FT.	Electricity Consumption Intensity: Median kWh Per SQ. FT. for Elem. Or Middle School 8.0
Elem. #1	56,829	588,000	10.3	8.0
Elem. #2	40,770	417,280	10.2	8.0
Elem. #3	45,273	526,750	11.6	8.0
Elem. #4	40,672	487,840	12.0	8.0
Elem. #5	35,314	366,440	10.4	8.0
Middle #6	47,633	366,280	7.7	8.0
Middle #7	40,769	369,840	9.1	8.0



About ASG Energy LLC

ASG Energy LLC has two centers of excellence one in Colorado (Denver and Canon City) and a second in Texas (San Antonio). ASG Energy is a national full-service energy efficiency company dealing exclusively in LED lighting with a successful track record of managing installations utilizing a White Glove Turnkey implementation process. ASG Energy utilizes professional project managers for Schools, Commercial and Industrial customers, and Medical Centers that generates rapid cost savings, reduces greenhouse gas emissions and improves facility lighting and safety.

For additional information please either click on the following Illuminating Energy & Cost Savings or contact ASG Energy directly at 210-610-0036 or email at info@asgenergyllc.com.