

WHITE PAPER

How Machine Learning Technology Increases Energy Efficiency

for K-12 Schools

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Look Beyond the Raw Data with Machine Learning Technology in K-12 Schools

Fundamental needs to reduce expenditures continue to plague all industries, including the K-12 education sector. According to [Fiona Burlig of Forbes](#), schools in the U.S. spend more than \$8 billion per year on energy, and energy costs are second only to labor costs in schools. With an average building age of 40, asserts the [U.S. Department of Energy](#), schools are simply not energy efficient.

Saving energy is the best solution to reduce expenses, and to maximize savings, school boards need to look beyond the assumed savings. Machine learning leverages historic, comparable-peer, and sitespecific data to prioritize energy efficiency improvements and changes in operations. Technically, machine learning is the capability of a system to self-recognize patterns and adapts existing algorithms to find more significant and more accurate correlations between connected data and identify the best actions to achieve the desired outcome.

As noted by [Burlig](#), machine learning can determine actual-versus-projected energy efficiency savings for a series of upgrades in a school careful data analysis.

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average energy spend for U.S. schools according to Forbes

There are countless variables to consider when creating a plan to apply machine learning in the K-12 environment, including floor plans, location, operations and more. Why do differences in school settings, floor plans, utility service provider benefits, state incentives, use of facilities, facilities management activities and government policies influence savings' realization?

Education Facilities Managers must look beyond the raw data. So, in this paper, we'll explore how machine learning translates into better energy efficiency in K-12 schools, focusing on these critical areas:

- **Why data aggregation is not enough with current energy improvement programs.**
- **How machine learning unlocks hidden data in real-time for immediate action.**
- **Why the human component remains critical to the success of new system implementation even when using machine learning.**
- **Where to focus improvements and analysis via machine learning to reap the most significant savings.**

While superintendents and school boards may consider full overhauls of equipment to tap into ENERGY STAR-rated appliances, including HVAC units, greater savings lie within the focal point, not necessarily complete equipment replacement. Facilities that implement new technologies, as well as retrofit existing facility assets with circuit- and asset-specific sensors to measure energy use versus performance, can achieve cost savings of 3 percent, revealed in the [study](#). However, these savings reflect an industry standard that considers all facilities under ideal operating conditions and improvements to [aging schools and assets](#). Outside of ideal conditions, approximately 24 percent of projected savings were realized, and chances of getting a completely new building are slim.

What's Wrong With Current Energy Improvement Programs?

Information overload - data analysis paralysis - plagues energy efficiency in K-12 facilities. For years, the conversation has focused on upgrading all facility assets.

While superintendents and school boards may consider full overhauls of equipment to tap into ENERGY STAR-rated appliances, including HVAC units, greater savings lie in understanding energy data. Facilities that implement new technologies, as well as retrofit existing facility assets with circuit and asset-specific sensors to measure energy use versus performance, can achieve cost savings of 3 percent, revealed in the [study](#). The application of machine learning in data management helps to prevent over-estimation of savings and ensures the right upgrades are prioritized.

Facilities Managers, financial executives, and Superintendents at K-12 Schools must track the right data, energy efficiency and cost reduction measures. They need to move toward granular data that focuses on timed increments for asset groupings versus durations for individual asset performance measurement. Another problem solved through machine learning is inaccurate cost savings' projections in securing funding.

California-based initiative, Prop 39, asserts [Pacific Gas and Electric \(PGE\)](#), allows for grant funding for energy-efficiency improvements. School Facilities Managers must still show a positive, projected ROI in the application. Unfortunately, continuous funding through the program for future asset upgrades also requires demonstrating the value achieved by previous upgrades.

While 3-percent savings amount to big bucks over the course of years, actual savings for participants have fallen short. Schools have only met 55 percent of projected value of savings. This further complicates the process for seeing real return on energy efficiency upgrades.

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Variances in runtime, geography and climate, age and manufacturer may lead to stark differences in the amount of savings possible. Since savings depend on isolated variables, education Facilities Managers should consider how changes in the facility operating environment compare to past performance and expenditures. In other words, how did the system change?

How did such changes affect energy costs and asset performance, and are changes contributing to savings comparable to industry standards in similar facilities?

Understanding data patterns and anomalies and predicting what may happen means going a step further than aggregating data through IoT-enabled devices. The use of machine learning to analyze data and make recommendations based on it to provide a desirable outcome is the solution. Achieving this goal requires Facilities Managers understand the problem in its entirety and why machine learning is essential to true savings in the facilities management or operating budget.

This begs the question: what can Facilities Managers do since data, alone, cannot save money?

Machine Learning Unlocks Data Secrets

The recent [study by the Energy Policy Institute at the University of Chicago](#) involving the use of machine learning in the classroom for energy efficiency upgrades and improvements in K-12 schools found the usefulness of the technology to extend beyond expectations. Machine learning, valued for its ability to improve decision-making processes continuously, can be applied to K-12 settings to enable better forecasting of returns for energy-efficiency improvements.

In the K-12 sector, the two highest expenses are staff and energy/utility costs. Making data-based decisions enables better utilization of energy resources. The decisions themselves must be based on accurate predictions in the forecasting and planning of runtime, maintenance and management of facility assets.

Although a full upgrade to all assets would be faster in terms of deciding what to do, it is not the most cost-effective strategy. Using machine learning technology in the process to measure projections against the facility-specific spend without making improvements is more cost-effective and verifiable.



The Human Element Is Still Vital to Success

Buildings do not use energy, people do. **Facilities Managers mistakenly assume machine learning equates to automated system controls.** Although automation is a viable solution for energy-efficient upgrades and reducing the carbon footprint of a given school district or single facility, it may require a steeper investment. More importantly, failure to utilize machine learning technology may result in changes to system settings that will not necessarily generate the greatest return. Automated technology acts on data, so poor data quality or analysis leads to incorrect outcomes and algorithms are somewhat susceptible to artifactual interpretations of data, notes the study.

Oversaturation of data and fixed effects estimators absorb too much data, resulting in inconsistencies in recommendations. However, machine learning gives managers and supervisors an opportunity to eliminate artifactual data from the equation.

This is partly why machine learning often includes the use of energy specialists to validate information. Cenergistic places an embedded energy specialist on campus to help the school board and other decision makers review data and verify recommendations and

monitor results. Regardless of which improvements are made, ranging from automation to metrics that track data consumption, someone still needs to monitor performance and progress. Once the machine learning system “learns” enough through its computational power and the adjustments made by the energy specialist, the system becomes self-competent. It gains the ability to recognize artifactual readings and optimize recommendations. Maintaining an energy specialist onsite allows for change management to occur, while serving as a human interface for school leaders and board members.

Where Should Facilities Managers and School Boards Focus Upgrades?

Significant costs are associated with upgrading all systems and assets at once. It is better to focus on smaller changes in the beginning. Focusing on assets with higher realization rates, namely HVAC and lighting systems, which generate cost savings of [103 percent](#) and [67 percent](#) respectively, can yield better energy-efficiency results, and therefore, lower energy expenditures.



Possible applications of machine learning for energy efficiency in K-12 schools include:

- **Collecting data on vacancy runtime.** This is the most accessible area to address. Energy use during vacancy hours may be unnecessary. For example, even with pre-start runtime on HVAC systems, there will still be periods where the system will be completely shut off. The building still has time to come to a comfortable temperature, and the costs of running the system all-night are reduced.
- **Identifying areas where energy is used unnecessarily.** For instance, sensors to detect natural lighting through windows could be used to denote when lighting systems are used unnecessarily.
- **Benchmarking results against energy costs without the use of machine learning and intervention.** This requires understanding the expected energy costs for a given facility based on historical data and likely weather patterns affecting facility assets.
- **Benchmarking results against similar-sized facilities in similar climates.** Even this comparison still must deal with confounding factors and subtle differences that affect performance. Instead of losing sight of the goal of energy savings, machine learning technology can benchmark performance against expectations and actual costs of similar facilities, ensuring the school is moving in the right direction.
- **Gaining asset group-level insight into energy usage behaviors, producing more accurate actual-to-project ratios.** Viewing asset-specific insight can help, but it leads to confusion when assessing energy savings realized, mainly when some assets may use more energy in the course of energy efficiency upgrades. Thus, it is better to leverage machine learning to compare data from across all improvements for a given asset type, like all lighting upgrades, to see what savings could look like. This builds a better business case for upgrades, enhancing the Prop 39 application's attractiveness. In turn, schools are more likely to receive approval for Prop 39 funding, which can be used to make energy-efficiency upgrades without affecting the school's budget.

Where Should Schools Focus Energy-Efficiency Upgrades?

Schools considering upgrades to facilities in the hopes of renewed cost savings and alignment of energy-efficiency goals and strategies need to understand and leverage the right type of data. Merely upgrading assets is a costly way of approaching potential savings through energy efficiency and analyzing historical data for a specific facility through machine learning isolates the real-world savings from the "noise."

Facilities Managers, K-12 school boards and superintendents must consider the areas where upgrades will be most effective, especially HVAC and lighting upgrades, and utilize data to make accurate projections for cost savings. Accuracy in savings will enhance budgeting for other school needs.





Schools seeking to save money through energy efficiency upgrades need to pick the low-hanging fruit first. Schools must retrofit facilities to collect granular data and upgrade older assets. Simply upgrading facilities and gathering data are not enough. Schools need to, analyze data through machine learning technology and work with an energy specialist to model data to site-specific needs to generate accurate energy forecasts. Since such actions are labor intensive and require countless hours data analytics, benchmarking algorithms processing and human beings working to ensure the right decisions are made, schools can effectively outsource the process to an experienced servicer, like Cenergistic.

Kickstart Your Process with the Right Tools and Resources Cenergistic Has to Offer.

Maximizing cost savings on energy efficiency upgrades depends on making the right decisions and the accuracy of data-based insights. Facilities Managers must move beyond the asset-specific methodologies and use machine learning to benchmark, measure, monitor and optimize facility assets to maximize energy efficiency and understand the real-world, verifiable results, demonstrating actual time to ROI and savings. This is the only way to transform energy-efficiency gains into benefits for students and teachers alike.

Learn more about the ways Cenergistic can provide insight into current versus past energy expenses, enhance ROI of energy improvements, benchmark performance against like facilities and more by [visiting us online](#) or calling 1 855.798.7779.

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